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Tectonophysics

8150 Plate Tectonics
OPHIOLITE EMPLACEMENT BY COLLISION BETWEEN THE SOLA PLATFORM AND THE SULAWESI ISLAND ARC, INDONESIA
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The emplacement of the large Sulawesi ophiolite belt results from a Miocene collision between the Sulawesi island arc and the Sula platform, a continental fragment. Marine and onshore geophysical and geological study show that the Batui thrust separates the ophiolite from sedimentary rocks deformed along the leading edge of the platform. The ophiolite represents the southern edge of the Cretaceous basin, which has been uplifted by oblique collision against the platform. The ophiolite is composed of harzburgite on the SE Arm and passes upward through a complex of gabbros and diabase dikes in the East Arm. Ophiolite melange underlies the harzburgites on the SE Arm, beneath low angle thrust contacts where seen. The melange is composed of thrust packets of both red shale and serpentine matrix variieties and has a moderate north to northeast dipping foliation. If regionally representative, this fabric is consistent with a northward component of movement of the platform along the Sulawesi margin. The regional structural pattern is for ophiolite to be thrust over melange or Mesozoic and Paleogene sedimentary rocks (to the east and south) but under the schist belt to the west. The Cretaceous basin may represent an older forearc basin, and the ophiolite is an uplifted part of its basement. Deformation of the ophiolite may have occurred in part on the sea floor prior to emplacement, but we feel that much of the deformation occurred during emplacement. The Sulawesi ophiolite is only one of a number of such bodies in the Indonesian region, each of which has a very different origin and tectonic history. (Ophiolite, melange, terrane collision, marine geophysics).
J. Geophys. Res., Bed, Paper 3B1160

8150 Plate Tectonics
COLLISION, ROTATION, AND THE INITIATION OF SUBDUCTION IN THE EVOLUTION OF SULAWESI, INDONESIA
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The island of Sulawesi, Indonesia, has been shaped and deformed as a result of collision with the Bale platform, a sliver of continental material from the northern margin of Australia-New Guinea. The collision has resulted in rotation of the north volcanic arm of Sulawesi and the development of the accretionary wedge of the North Sulawesi Trench. The North Sulawesi Trench changes laterally from a zone of no active deformation in the eastern part to a wide accretionary wedge to the west. Early stages of thrusting produced a steep frontal slope (5–15°), indicative of relatively high basal shear stress, whereas the more advanced (outward) zone of thrusting produced a gentle (2°) slope, consistent with low basal shear stress. Reported paleomagnetic data suggest post late Eocene counterclockwise rotation of the North Arm with respect to the Celebes Basin about the eastern end of the arc. Convergence between the North Sunda Basin and SE Sulawesi is documented by the presence of the Tolo thrust. Its outcrop is strongly arcuate and its accretionary wedge varies in width from a minimum of a few km at each end to a maximum of 30–40 km in the central part. The northern end transforms to the left-lateral Matano fault, with a reported offset of 20 km in Holocene sediments. Also, stations within 30 km of the 1978 Ceram earthquake underwent localized tilt change up to a year before that event. If tectonic, these variations are on a broader scale of temporal scale than those for the Batch fault network during the period 1975–1978, the geomagnetic gradient is approximately uniform across the strait, with no development of any significant anomalies. This pattern is roughly coincident with the 1975.7–1976.7 secular change in nearly all of California. It is followed by a marked increase in regional secular variation. Large coherence between anomalous variation at different stations is not seen, other than the year before the Batch fault earthquake, suggesting that local field variation occurs on a scale of less than 10 km.

Coseismic geomagnetic events are not found at the times of the Batch and Ceram earthquakes. Model calculations suggest that observable events are not expected. If the observed changes are due to stress, they indicate that changes of tectonic stress are sufficiently large than seismic stress release. (Tectonomagnetism, California).
J. Geophys. Res., Bed, Paper 3B1066

8150 Plate tectonics
EARTHQUAKES, PLATE SUBDUCTION, AND STRESS REVERSALS IN THE EASTERN ALEUTIAN ARC
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Plate subduction beneath the 1,500 km long segment of the eastern Aleutian arc between Kodiak and Atka islands (154°W and 176°W longitudes) is studied with observations from teleseismic data. The primary data base consists of hypocenters of earthquakes (for the period 1965 to 1975), carefully selected from the Bulletins of the International Seismological Centre, and of 44 new focal mechanism solutions.

The principal results of this study are: hypocenters of intermediate-depth earthquakes in the eastern Aleutians appear to define a weakly developed double seismic zone at depths between 70 and 170 km. Additional evidence for a double seismic zone comes from focal mechanisms which generally show down-dip directed P axes for earthquakes in the upper zone and down-dip directed T axes in the lower zone. Major features of the double zone can be explained by thermoelastic stresses in the downgoing plate. The observed predominant down-dip stress polarity at intermediate depths in the descending plate reverses along strike of the arc. This stress reversal coincides in map view with a change from a continental to an oceanic arc. The coincidence may result from spatial differences either in the coupling between the plates at shallow depths or in the rheology of the surrounding – oceanic versus continental – mantle. Alternatively, the stress reversal may be related to the time since the last great earthquake. If the observed stress polarity relates to the elapsed time since the last great earthquake it may be a significant observation for long- to intermediate-term prediction of great thrust earthquakes in subduction zones. Portions of the eastern Aleutian arc where down-dip tensios predominates contain one or more seismic gaps that appear to have a high probability for great earthquakes in the next few decades.

A moderate-sized bathymetric feature in the Pacific plate, the Amlia Fracture Zone, modifies subduction and produces a bend or offset in the downgoing plate, as well as an offset in the line of active volcanoes in the upper plate. Subduction of the fracture zone appears to also cause formation of a small basins on the arc platform and some aseismic behavior of a 100-km long segment of the main thrust zone. (Aleutians, earthquake mechanisms, stress reversal, subduction),
J. Geophys. Res., Bed, Paper 3B1213

8190 Tectonophysics (Instruments and techniques)
LOCALIZED SEISMOMAGNETIC FIELD CHANGES NEAR ACTIVE FAULTS IN CALIFORNIA 1974–1980
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Daily averages of magnetic difference fields, for the years 1974–1980, between 11 magnetometers on the San Andreas fault (between San Francisco and the Mexican border) have been analyzed to isolate the geomagnetic variation of crustal origin and to test if it is related to stress. Field changes

Erosion of U.S. Shorelines

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We have assembled data on the rate of change of the U.S. shorelines, including those of the Great Lakes. Obtained from geologists and engineers, our data base covers 1689 sites. The national average (unweighted) shoreline erosion rate is 0.40 m/yr. Along the Atlantic coast the average rate of recession is 0.8 m/yr; the Gulf coast is 1.8 m/yr; and the Pacific coast rate, including Alaska, is 0.005 m/yr. Statistics for Delaware Bay, Chesapeake Bay, and the Great Lakes are also summarized.

Introduction

The River and Harbor Act of 1968 issued a mandate to the U.S. Army Corps of Engineers to compile an inventory of the nation's coastlines, including the Great Lakes. The final summary, "A Report on the National Shoreline Study," indicates that of the nation's 84,240 miles of coastline, 20,500 miles could be categorized as "seriously eroding" at the time the study was initiated [*U.S. Army Corps of Engineers* (USACE), 1971]. Nine regional reports provide specific information and proposals for corrective measures.

In evaluating the National Shoreline Study, the General Accounting Office determined that lack of adequate funding and personnel and inconsistencies in methodology and assessment criteria prevented the study from satisfying any but the broadest requirements of the mandate [*U.S. General Accounting Office*, 1975]. However, to date, the National Shoreline Study has remained the only comprehensive assessment of coastal conditions on a nationwide scale.

In 1979 we reported on rates of shoreline erosion of the mid-Atlantic coast from New Jersey to North Carolina [*Dolan et al.*, 1979]. Since then, under sponsorship of the U.S. Geological Survey, we have assembled data on shoreline changes for the remainder of the United States, including Chesapeake Bay, the Great Lakes, and Alaska. The information is designed for presentation as a series of U.S. Geological Survey maps drafted at a 1:2,000,000 scale, as a 1:7,500,000 scale map in a *National Atlas* format. The assembled data bank of shoreline rates of change is accessible in a computerized Coastal Erosion Information System (CEIS) at the University of Virginia. We are currently analyzing coastal hazards and are developing statistical evaluations of vulnerability to coastal processes. These data are included in CEIS and are detailed in a separate map series. We will discuss coastal hazards in a subsequent report. In this paper we present a summary of the differences in erosion rates for various geographic regions of the United States.

Mechanisms for Shoreline Change

Shorelines recede when the forces of erosion exceed the amount of sediment supplied to the coast. The greater the deficiency of sand, or the higher the wave energy, the more rapid the rate of erosion. Any of three factors (energy, sediment supply, or sea level) can vary through time and change the balance.

Sediment Transport

Three principal classes of sand movement are responsible for most changes occurring on beaches and barrier islands: (1) movement along the shore when waves approaching the coast at an angle set up sediment transporting processes called longshore currents; (2) movement across the shore during periods of high waves and tides when water levels may be elevated to the point that the beach is overwashed; and (3) movement of sediment by wind action.

All beaches and barrier islands respond to these dominant processes; there are, however, significant regional differences [*Fisher*, 1968; *Godfrey et al.*, 1979]. In the northeast, for example, overwash occurs less frequently, and large dunes and cliffs have formed from sediment eroded from glacial deposits, while along the mid-Atlantic coast, where tide ranges are lower, overwash is a more common process.

Storms

Hurricanes are responsible for extensive damage [illegible] mid-latitudes. Each year, between 30 and 40 such storms generate potentially damaging surges and waves. The Lincoln's Birthday storm of February 12, 1973, for example, caused severe beach erosion along the coast from Long Island, New York, to Miami, Florida, and the Ash Wednesday storm of March 7, 1962, produced waves over 10 m high, damaging millions of dollars of property along the mid-Atlantic coast [*Cooperman and Rusendal*, 1962]. Similarly, a series of extratropical storms in December 1982 and January 1983 caused extensive damage to the beaches and shoreline developments along the California coast.

Water Levels and Sea Level Fluctuations

Gradual variations in water level occur through tides, storm surge, and long-term sea level fluctuations. Tidal action alone has little effect on long-term shoreline change, but when storm surge and high waves are superimposed, elevation and depression of the water level becomes an important agent in sediment transport.

As a result of the moon's elliptical orbit, there is a minimal distance between the moon and earth once during each revolution. When this coincides with syzygy, higher tides, called perigean spring tides, are generated. *Wood* [1976] shows a strong coincidence of catastrophic storms and perigean spring tides. One hundred of the most severe coastal storms between 1635 and 1976, including the Ash Wednesday storm of 1962, occurred at the time of perigean spring tides.

During the Wisconsin glacial period, approximately 15,000 B.P., sea level was about 120 m lower than it is today, and the shorelines of the Atlantic and Gulf coasts were 60–150 km seaward of their present position. Sea level reached within several meters of the present level about 5000 yr ago and has remained fairly stable since then. However, a slow rise over the past 2000 years has resulted in recession of shorelines and enlargement of coastal bays and sounds. Over the past 100 yr, the rise has been rapid, totaling slightly more than 30 cm [*Hicks and Crosby*, 1975].

Measurement of Shoreline Change

The national shoreline erosion maps are based on data acquired by a variety of methods ranging from precise engineering surveys to general appraisals of old photographs. The advantages and disadvantages of these methods are listed below [*Dolan et al.*, 1978]:

Repeated Ground Surveys

Cost: Data acquisition is expensive because of the large number of man hours required. Accuracy: Resolution on the order of 0.01 m ground distance. Advantages: (1) Measurements are direct. (2) Individual measurements may be updated at relatively moderate cost. (3) Methodology is commonly understood by the public. (4) Measurement is commensurate with local property records. Disadvantages: (1) Historical timeline of data usually not available. (2) Accuracy of measurement greatly exceeds the resolution of shoreline definition. (3) Along-the-coast density is poor. (4) Systematic updating of extensive coastal reaches is expensive and time consuming.

Historic maps and charts

Cost: Existing maps and charts are generally inexpensive, but cost associated with generating new maps are high. Accuracy: Estimates of map accuracy are often unavailable, but can be estimated in tens of meters. Advantages: Maps and charts from the mid-1800's are available for much of the United States, thus providing an unusually long time frame for determination of shoreline changes. Disadvantages: (1) Irregular availability. (2) Unstable map bases. (3) Low accuracy and resolution. (4) No correction for sea state or tide level.

Aerial Photography

Cost: Given the along-the-coast density of available data, the cost is rated as low. Accuracy: Resolution of data varies with scale of photography and methods employed. Errors in the range of 2.5 m ground distance are typical [*Dolan et al.*, 1980]. Advantages: (1) Along-the-coast resolution is high. (2) Historical data for the last 40 years are usually available. (3) Data are time-specific. (4) Shoreline definition is within the resolution error of systems being analyzed. (5) Repeated coverage is inexpensive if extensive coastal areas are included. (6) Frequent coverage in time is

Data Collection and Analysis

The national shoreline change data bank was created from the best and most comprehensive of existing information sets contributed by coastal scientists nationwide. Initially, the approach was to obtain maximum coverage by using the most readily available data sets. Preference was given to studies with a wide range, both temporal and spatial, and which were already available in graphic form. Once the broad reaches were covered, higher resolution, site-specific information was introduced. Appropriate district and division offices of the U.S. Army Corps of Engineers were contacted for information. Because of their involvement with the National Shoreline Study, the Corps was able to provide up-to-date lists of coastal scientists and other contacts who could provide data. Requests for data were also made to state offices with responsibility for coastal affairs, sea grant offices, and university departments.

Most contacts provided reports, data sets, and/or further contacts. It was quickly established that the mid-Atlantic, southeast, Gulf, and Great Lakes areas are data rich. In contrast, the Pacific, Alaskan, and northeast coasts have not been surveyed as extensively or quantitatively. These areas lack information because shoreline change is episodic and/or catastrophic so a continuous day-to-day threat is not perceived by the coastal communities, or the population densities are so low that continuous shoreline monitoring is not a high priority.

As the data were collected, they were transferred onto 1:2,000,000 scale Mylar transparencies. In many instances, two or more information sets were available for a given reach. In such cases, time span and currency of information were considered. More recent studies were chosen over older ones because they are generally made with knowledge of preceding work and reflect the earliest information. Where a choice of length of historical record appeared, long-term rates were favored over short term for two reasons: More of the data sets present average rates based on the study of charts drafted in the late 19th century onto which successive series of maps and aerial imagery were superimposed, so, using the longest period of record made the majority of studies similar in terms of the initial baseline, and the effects of single catastrophic events were filtered.

In areas where detailed information was not available for periods of over 100 yr, the measurement base or type became a criterion for inclusion. Since the development of mapping-quality aerial photography in the 1930's, the quantification of shoreline changes over large reaches of the coast has become possible. The period of record is generally 40–50 yr, and the studies or data are all current, so the effects of recent engineering structures are usually included.

The rate of shoreline change, length, and final year of study and measurement base are indicated on our 1:2,000,000 scale maps for each reach. At this scale, 2 km ground distance is 1 mm map distance. To record the maximum amount of information, all data were processed to conform with a minimum mapping unit of 5 mm. Where barrier islands are present, islands shorter than the minimum mapping unit are kept as a single unit. We attempted to group similar recession rates together but not to average rates for islands with significantly higher or lower rates on adjacent islands.

After all the data sets were recorded on the Mylar maps, the information was processed to create a set of maps, also at a scale of 1:2,000,000, on which rate classes are depicted in an easy to read manner (Figure 1). Our objective was to have broad enough classes to include significant variation about the low resolution means yet narrow enough to do justice to those high resolution studies with low variances. The errors involved in obtaining average rates of change from limited numbers of profiles is somewhat diminished by the use of rate classes. The broad classes will bracket the true rate for a given reach in an acceptable graphic form. For more detailed information, we will refer the users to the original data sources.

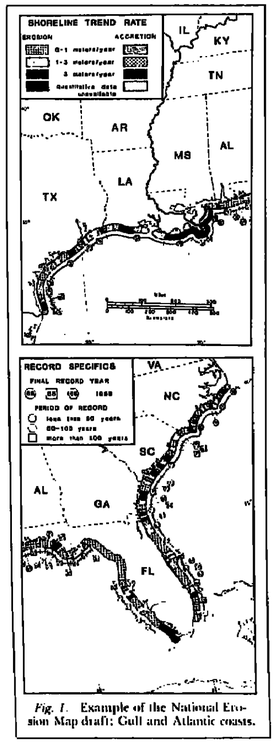

Fig. 1. Example of the National Erosion Map draft: Gulf and Atlantic coasts.

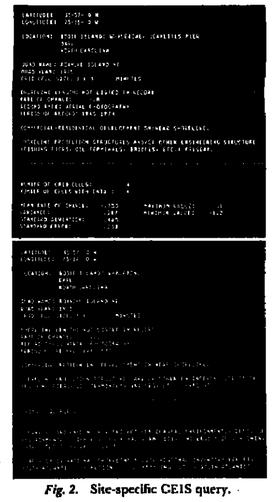

Fig. 2. Site-specific CEIS query.

Coastal Erosion Information System

All information gathered for the map series is contained in an easy-access computerized information system [*May et al.*, 1982]. CEIS is designed to provide the user with original rate-of-change data, primary sources, statistical summaries, and notes regarding special interest features for any given reach of coast. The information is stored in grid cells, which are 3 min latitude or longitude on a side. Each cell is filed and identified by the latitude and longitude of its northwest corner.

The system is designed in a tutorial mode for easy user access. Once logged into the system, the user is asked to enter the latitude and longitude of the area of interest. Rate-of-change information is printed out for each 3 min grid cell. Statistical summaries and data sources are listed for the reach (Figure 2).

Migration of the U.S. Shorelines: Summary

We used CEIS to generate statistical summaries of rate-of-change data for each coastal state and for reaches with similar geology and shoreline geomorphology (Tables 1 and 2).

In Table 1, the mean rate of change for each coastal state, within-state standard deviations of these rates, and the extreme range of rates are listed. Along the Atlantic coast, the average erosion rate is about 0.8 m/yr (recession); with the Virginia barrier islands, Maryland, and New Jersey having the most pronounced erosion rates, up to 4.1 m/yr. The rapid erosion of Virginia's shoreline is largely confined to the Virginia barrier is-

Article *(cont. from p. 521)*

TABLE 1a. Rate of Change Statistics for States and Regions: Oceanic Coastlines

Region	x̄, m/yr*	σ	Total Range*		N†
Atlantic Coast	−0.8	3.2	25.5	−24.6	510
Maine	−0.4	0.6	1.9	−0.5	16
New Hampshire	−0.5	—	−0.5	−0.5	4
Massachusetts	−0.9	1.9	4.5	−4.5	48
Rhode Island	−0.5	0.1	−0.3	−0.7	17
New York	0.1	3.2	18.8	−22	42
New Jersey	−1.0	5.4	25.5	−15.0	99
Delaware	0.1	2.4	5.0	−2.8	7
Maryland	−1.5	3.0	1.3	−8.8	9
Virginia	−4.2	5.5	0.9	−24.6	34
North Carolina	−0.6	2.1	9.4	−6.0	101
South Carolina	−2.0	3.8	5.9	−17.7	57
Georgia	0.7	2.8	5.0	−4.0	31
Florida	−0.1	1.2	5.0	−2.9	105
Gulf of Mexico	−1.8	2.7	8.8	−15.3	358
Florida	−0.4	1.6	8.8	−4.5	118
Alabama	−1.1	0.6	−0.8	−3.1	16
Mississippi	−0.6	2.0	0.6	−6.4	12
Louisiana	−4.2	3.3	3.4	−15.3	106
Texas	−1.2	1.4	0.8	−5.0	106
Pacific Coast	−0.0	1.5	10.0	−5.0	305
California	−0.1	1.3	10.0	−4.2	164
Oregon	−0.1	1.4	5.0	−5.0	86
Washington	0.5	2.2	5.0	−3.9	46
Alaska	−2.4	2.0	2.9	−6.0	69

*The negative values indicate erosion; the positive values indicate accretion.
†Total number of 3-min grid cells over which statistics are calculated.

TABLE 1b. Rate of Change Statistics for States and Regions: Bays and Lakes

Region	x̄, m/yr*	σ	Total Range*		N†
Delaware Bay					
New Jersey	−1.9	1.3	0.3	−3.0	13
Delaware	−1.3	2.1	5.0	−3.0	12
Chesapeake Bay	−0.7	0.7	1.5	−4.2	136
Western shore	−0.7	0.5	1.5	−1.9	67
Maryland	−0.7	0.3	−0.1	−1.5	35
Virginia	−0.8	0.7	1.5	−1.9	32
Eastern shore	−0.7	0.8	0.1	−4.2	69
Maryland	−0.8	0.9	−0.3	−4.2	47
Virginia	−0.5	0.4	0.1	−1.2	22
Great Lakes	−0.7	0.5	0.6	−2.7	327
Lake Erie	−0.7	0.6	−0.2	−2.4	98
Ohio	−0.6	0.6	−0.2	−2.2	68
Pennsylvania	−0.3	0.1	−0.2	−0.4	14
New York	−1.4	0.6	−0.5	−2.4	20
Lake Ontario	−0.5	0.2	−0.2	−1.2	58
Lake Huron	−0.4	0.3	−0.3	−1.3	28
Lake Michigan	−0.6	0.8	0.6	−9.9	184
Western shore	−0.6	0.4	0.6	−1.5	62
Eastern shore	−0.7	0.9	0.3	−9.9	122
Wisconsin	−0.7	0.3	−0.3	−1.5	46
Illinois	−0.2	0.4	0.6	−0.9	16
Indiana	−0.4	0.5	−0.3	−0.9	12
Michigan	−0.7	0.9	−0.3	−9.9	110
Lake Superior	−1.3	0.7	−0.3	−2.7	35
Minnesota	−0.8	0.4	−0.3	−1.5	16
Wisconsin	−1.8	0.6	−0.9	−2.7	19

*Negative values indicate erosion; the positive values indicate accretion.
†Total number of 3-min grid cells over which the statistics are calculated.

TABLE 2. Rate of Change Statistics for Coastal Landform Types

Region	x̄, m/yr*	σ	Total Range*		N†
Mud flats					
Fla.	−0.3	0.9	1.5	−1.5	9
La.-Texas	−2.1	2.2	3.4	−8.1	84
All Gulf	−1.9	2.2	3.4	−8.1	93
Rock shorelines					
Atlantic	1.0	1.2	1.9	−4.5	36
Pacific	−0.5	—	−0.5	−0.5	7
Pocket beaches					
Atlantic	−0.5	—	−0.5	−0.5	9
Pacific	−0.2	1.1	5.0	−1.1	144
Sand beaches					
Maine-Mass.	−0.7	0.5	−0.5	−2.5	17
Mass.-N.J.	−1.3	1.3	2.0	−4.5	22
Atlantic	−1.0	1.0	2.0	−4.5	39
Gulf	−0.4	1.6	8.8	−4.5	121
Pacific	−0.3	1.0	0.7	−4.2	19
Sand beaches with rock headland	0.3	1.9	10.0	−5.0	134
Deltas	−2.5	3.5	8.8	−15.3	155
Barrier Islands					
La.-Texas	−0.8	1.2	0.8	−3.5	76
Fla.-La.	−0.5	1.7	8.8	−4.5	82
Gulf	−0.6	1.5	8.8	−4.3	158
Maine-N.Y.	0.3	2.6	4.5	−1.5	12
N.Y.-N.C.	−1.5	4.5	25.5	−24.6	153
N.C.-Fla.	−0.4	2.6	9.4	−17.7	256
Atlantic	−0.8	3.4	25.5	−24.6	421

*Negative values indicate erosion; the positive values indicate accretion.
†Total number of 3-min grid cells over which the statistics are calculated.

average. Erosion rates along Chesapeake Bay's shoreline are of the same order as the Atlantic coast average. Overall, the Atlantic coast can be characterized as a receding system, with 408 of the 510 grid cells (79%) showing some measure of erosion.

The Gulf coast states have the distinction of having the most rapid average erosion rates (1.8 m/yr) on a national scale, almost 5 times the average for our total 1089 sites. Within the Gulf coast region, the deltaic coast of Louisiana is by far the most dynamic (4.2 m/yr erosion). Like the Atlantic coast, the Gulf region can be described as eroding. However, the percentage of receding areas is somewhat less (93%). This is due, in part, to the large area covered by the active Mississippi delta system and, in part, to extensive regions in southern Florida that are essentially unmapped.

In general, the Great Lakes shorelines are receding at rates (0.8 m/yr) commensurate with the Atlantic coast. The highest erosion rates are found along the shorelines of Lake Superior (1.3 m/yr) and Lake Erie (0.7 m/yr). Both these lakes have long east-west dimensions and, thus, large fetches during the eastward passage of storms. The Pacific coast, including Alaska, has the lowest erosion rates (0.005 m/yr), as indicated by the available sources, as well as the lowest overall percentage of eroding areas (less than 50%).

While erosion rates for the bays and lakes are of the same order as for ocean coasts, the along-the-coast variability is much lower. For example, Chesapeake Bay (0.7 m/yr recession) and the Atlantic coast (0.8 m/yr recession) have about the same mean rate of change, but the along-the-coast variability for the Atlantic coast (±3.2 m/yr) is an order of magnitude higher than that of Chesapeake Bay (±0.7 m/yr).

When the national erosion rates are grouped on a basis of the shorezone geology, the resulting patterns are, for the most part, as one would expect (Table 2). We used the four rock-type categories listed on the coastal landforms map published in the *National Atlas [U.S. Geological Survey,* 1970] and subdivided each rock type into the geographic regions. Coasts with fine-grained sediments, deltas, and mudflats have the highest mean erosion rates (2.0 m/yr recession), while most sandy beaches and barrier islands are eroding at lower rates (0.8 m/yr). The rock shorelines of the Atlantic coast (Maine) and the glacial rebound areas are accreting at 1.0 m/yr.

Table 2 also provides a listing of the erosion rates for the 295 Gulf and Atlantic coast barrier islands. The Gulf coast barrier islands are receding at a mean rate of 1.6 m/yr, with some islands having erosion rates as high as 15.3 m/yr. The Atlantic coast mudflats have the highest mean erosion rates (2.0 m/yr recession), while most sandy beaches and barrier islands are eroding at lower rates (0.8 m/yr). The rate of Atlantic coast barrier island recession over the last 2000 yr varied as the rate of the sea level rise changed, the supply of sediment waned, and the inner shelf slope evolved. Some of the eroded material has been lost into large offshore sediment sinks, such as Diamond Shoals off Cape Hatteras. Much of it, however, has remained within the barrier island sediment budget and has contributed to spit growth, inlet filling, dune building, and storm overwash deposits.

Acknowledgments

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Forum

Methane and Seismicity: A Reply

In a recent Forum article in *Eos* ("Methane in Association With Seismic Activity," June 14, 1983, p. 410), R. S. Oremland presents observations which he claims contradict the deep methane gas hypothesis. His principal case rests on observations of one M 5.7 earthquake near the volcanic area of Mammouth Lakes, California, which did not result in any increase in methane content of gases in four local seeps.

In our published discussions of the deep gas hypothesis [*Gold and Soter,* 1980, 1982], we proposed (1) that outgassing from mantle depths is an ongoing process both in volcanic and nonvolcanic regions; (2) that the gases CO_2 and CH_4 are the principal carriers of the surface excess carbon; (3) that chemical equilibrium between CO_2 and CH_4 in the presence of hot or liquid rock is strongly shifted towards CO_2, especially in the low pressure domain, and that therefore active volcanic or high heat flow regions would be less likely to exhibit CH_4; and (4) that faultlines, particularly those which are seismically active, are locations where outgassing in cool regions can be sampled. The evidence there is that flames from the ground are often seen in association with major earthquakes. (Just as in many mud volcano eruptions, ignition of combustible gases can be attributed to electrostatic effects.) Methane is also observed in many of the major crustal rifts, together with helium having the high ^3He to ^4He ratio indicative of deep origin [*Lupton,* 1983].

Based on this type of evidence we concluded that methane was very likely the combustible component that escaped sometimes during earthquakes, although hydrogen is also a good possibility. Of course there are great regional variations in the type of gas found in deep wells and we would expect this to be reflected in regional variations in the gases that escape during earthquakes. The observation of one moderate earthquake with no associated increase in the methane outgassing in four seeps can hardly be regarded as a contradiction to the deep gas hypothesis. It also does not add to or subtract from the evidence of flames in the Owens Valley earthquake of 1872. All that can be said is that no combustible gases were observed in the Mammouth Lakes earthquake of 1978, just as no combustible gases have been observed in many other earthquakes. Combustible gases have, however, been observed in a large number of other cases, particularly during major earthquakes in which faulting extended to the surface.

The low levels of methane found in most volcanic emissions may be due either to its absence in the source gases entering the magma chamber, or to its oxidation there, which must certainly be expected. At great depths, methane tends to be pressure-stabilized despite the high temperatures. But most of the deep source methane which finds its way into the liquid rock of a volcano will probably be oxidized to CO_2 as it comes into contact at reduced pressures with the abundant oxygen available in the hot magma. Nevertheless, methane has been detected in numerous volcanic emissions, sometimes even at combustible concentrations.

Oremland claims that such mineral-catalyzed oxidation of CH_4 to CO_2 is not supported by experimental evidence and he cites *Sackett and Chung* [1979] to that effect. However, those authors demonstrate merely the absence of isotopic and chemical equilibrium between CH_4 and CO_2 heated to 500°C for several days. *Giggenbach* [1982] has since shown theoretically that equilibration under such conditions is expected to be negligible in times less than a year, but should go to completion in a few hundered years. Certainly at the high temperatures (and low pressures) of a volcanic vent the equilibration will be very rapid.

The statement that organic debris can account for some of the methane in volcanoes does not contradict our hypothesis that some volcanic methane has a deeper origin, as Oremland seems to suggest.

Lastly, Oremland claims that "observations of isotopically heavy methane...in association with plumes of ^3He emanating geothermal regions...does not prove a mantle origin for the methane because the gas may have been 'stripped' out of the crust with upward movement of ^3He." It must of course be the other way around. ^3He is never present at a level of more than one part in 10^7 of any natural gas. How this minute trace constituent would sweep up more than ten million times its own volume as it moves through the crust would surely be a major puzzle. It is more reasonable to suggest that the CO_2 and isotopically heavy CH_4 are carriers for the ^3He with which they are so often found associated.

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Cornell University
Ithaca, NY 14853

News

Solar System Around Vega?

The Infrared Astronomy Satellite (IRAS), launched in January, has discovered a shell or ring of particles around Vega, the brightest star in the constellation "The Lyre" and one of the brightest stars in the sky. The discovery provides the first direct evidence that solid objects of substantial size exist around a star other than the sun; it also offers the first scientific opportunity to study what may be an early solar system accreting from stellar debris, much like our solar system is believed to have formed.

IRAS measured the material to be at a temperature of 90° Kelvin, about the temperature of particles in Saturn's innermost rings. Although the sensitive telescope on IRAS cannot discern the individual particles around Vega, scientists speculated that the particles could range from the size of a pearl to the size of an asteroid or planet. In addition, the composition of the particles is open to debate. The material around Vega probably has not reached the same stage of evolution as our solar system because Vega is less than one fourth as old as our sun.

Vega, about 26 light years from earth, is a standard against which other stars' brightness and spectra are measured by astronomers. In fact, it was while IRAS scientists H. H. Aumann of the Jet Propulsion Laboratory and Fred Gillett of Kitt Peak National Observatory were using Vega to calibrate the IRAS telescope that they discovered that the star appeared much brighter and larger in infrared light than expected based on IRAS observations of similar stars. The scientists determined that the radiation is coming from an extended region around the star stretching out roughly 80 astronomical units from Vega. Aumann and Gillett were working with telescope data at the IRAS tracking and data acquisition center at the Rutherford Appleton Laboratory in Chilton, England, when they made the discovery.

The IRAS infrared telescope measures heat radiation emitted by celestial objects. The telescope is scheduled to operate through January; its mission is to survey and map all infrared objects in the sky. Followup studies from infrared, optical, and other telescopes will gather information on the distribution and composition of the material. IRAS is a joint project of the United States, the United Kingdom, and The Netherlands. The Jet Propulsion Laboratory is the U.S. management center for IRAS.

New Editors Appointed

New editors have been appointed for the Atmospheres and the Oceans sections of the *Journal of Geophysical Research* (JGR), for the policy sciences portion of *Water Resources Research* (WRR), and for *Reviews of Geophysics and Space Physics* (RGSP).

William L. Chameides, associate professor at the School of Geophysical Sciences at the Georgia Institute of Technology has been appointed editor of JGR–Atmospheres beginning January 1, 1984. He succeeds Ralph Cicerone.

Chameides, who has been an associate editor JGR and *Geophysical Research Letters* (GRL), received his B.A. in physics from the State University of New York at Binghamton in 1970 and his Ph.D. in geology and geophysics from Yale University in 1974. Manuscripts submitted to JGR–Atmospheres after October 1, 1983, should be sent to **William L. Chameides, School of Geophysical Sciences, Georgia Institute of Technology, Atlanta, GA 30332** (telephone: 404-894-3883).

James J. O'Brien, professor of meteorology and oceanography at Florida State University (FSU), has been appointed editor of JGR–Oceans beginning January 1, 1984. He succeeds A. D. Kirwan, Jr.

O'Brien, director of graduate studies at FSU's department of meteorology, received his B.A. in chemistry from Rutgers University in 1957 and his Ph.D. in meteorology from Texas A&M University in 1966. He has served as an associate editor of GRL and is the immediate past president of the AGU Oceanography Section. Manuscripts submitted to JGR–Oceans after October 1, 1983, should be sent to **James J. O'Brien, Editor, JGR-Oceans, P.O. Box 2175, Tallahassee, FL 32316** (telephone: 904-644-4581).

Ronald G. Cummings, professor of economics at the University of New Mexico, has been appointed editor of the policy sciences section of WRR beginning January 1, 1984. He succeeds Jared L. Cohon.

Cummings, director of the university's program in natural resources economics, received his B.S. in economics from the University of Missouri in 1963 and his Ph.D. in economics from the University of Missouri in 1968. He was chairman of the department of resource economics at the University of Rhode Island from 1972 to 1975 and is president of the Association of Environmental and Resource Economists. Manuscripts submitted to WRR after October 1, 1983, in the policy sciences of water resources including economics, systems analysis, sociology, and law, should be submitted to **Ronald G. Cummings, Department of Economics, University of New Mexico, Albuquerque, NM 87131** (telephone: 505-277-3056).

James R. Heirtzler, senior scientist at the department of geology and geophysics at the Woods Hole Oceanographic Institution (WHOI), has been appointed editor of RGSP beginning July 1, 1984, succeeding Andrew F. Nagy; Heirtzler will be editor-designate from January 1 to June 30, 1984. Papers submitted to RGSP through the first quarter of 1984 should continue to be sent to Nagy.

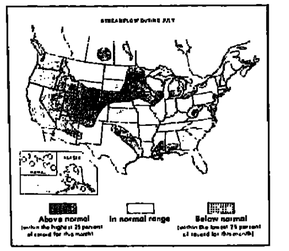
Heirtzler, who has published extensively in the field of geomagnetism, is the president of AGU's Geomagnetism and Paleomagnetism Section and was chairman of WHOI's department of geology and geophysics from 1969 to 1976. He received his B.S. in physics from Louisiana State University in 1947 and his Ph.D. in physics from New York University in 1953. Heirtzler was director of the Hudson Laboratories of Columbia University from 1967 to 1969 and director of scientific research of the Joint Oceanographic Institutions, Inc., in 1979–1980.

July Streamflow

The lingering effects of a record-deep mountain snowpack continued to keep streamflows at near record high levels in much of the western United States during July. Elsewhere in the nation, a lack of rainfall and prolonged high temperatures contributed to declining streamflows, and parts of the northeast and southeast reported near record-low streamflows, according to a monthend check on water conditions by the U.S. Geological Survey (USGS). (See map, courtesy of USGS.)

USGS hydrologists said that record-high streamflows were set in California, Colorado, Oregon, Utah, Washington, Wyoming, and Iowa based on reports from 172 key index stations across the country. Well above average flows during July, within the highest 25% of record, were reported at 57 of the index gaging stations. Of the remaining stations, 98 reported near-average flows and 17 reported well-below average flows. Along the east coast, 12 of the 72 key index stations from Maine to Florida reported well below average flows for the month. In the extreme southwest, two stations reported their lowest July flows for the period of record.

The combined flow of the three largest rivers in the conterminous United States—Mississippi, St. Lawrence, and Columbia—which drain more than half of the 48 states, reflected the generally wet conditions. The average flow for the three rivers during July was 3346 billion liters per day (bld) (736 billion gallons per day), 20% above average, but down seasonally by 48% from June's flow. The flow of these large rivers serves as a convenient check for hydrologists in appraising the nation's surface water conditions.



Working in cooperation with federal, state, and local officials, the USGS routinely monitors the quantity and quality of the nation's surface and groundwater resources at more than 45,000 stations across the country. Flows of the "Big Five" rivers in July were as follows: Mississippi River at Vicksburg, Miss., 1614 bld, 29% above average for July, but 56% below the near-record flow in June; Columbia River at The Dalles, Ore., 905 bld, 10% above average, but 34% less than last month's flow; St. Lawrence River near Massena, N. Y., 827 bld, 3% above average, but down 5% from June's flow; Missouri River at Hermann, Mo., 323 bld, 45% above average for July, but down 28% from June; and the Ohio River at Louisville, Ky., 150 bld, 4% above average, but 39% below the June flow.

News *(cont. on p. 521)*

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For speediest treatment of contributions send three copies of the double-spaced manuscript to one of the editors named below and one copy to AGU.

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Cover. Enhanced sun illumination image of the geoid over the South Pacific derived from SEASAT and GEOS-3 altimeter data. Illuminations are from the northwest (top/center) and southeast (bottom). Shorter wavelength geoid undulations reflect bathymetric features such as large seamounts (e.g., San Felix Island at 26.5°S, 280°E) and fracture zones (e.g., the Heezen, Tharp, and Udintsev Fracture Zones, bottom center). The largest linear feature is the Eltanin Fracture Zone, which is associated with a major age offset in the seafloor. The northwest extension of this fracture zone is the Louisville Ridge. The Kermadec Trench appears in the northwest corner. In addition to these known features, this map reveals a number of fracture zones and seamounts that have not been detected previously or were poorly charted because of sparse bathymetric coverage. (Photo courtesy of David T. Sandwell, National Geodetic Survey, Rockville, Md.)

NSF Education Grants

The National Science Foundation (NSF) is soliciting proposals for the development of educational materials and training workshops for science and mathematics programs in elementary and secondary schools. Proposals may be submitted at any time and must specifically deal with projects in mathematics, engineering, the natural sciences (including atmospheric, earth, and ocean sciences, physics, astronomy, chemistry, and biology), and computer science.

Projects for materials development may deal with programs for the continuing education of teachers; the development of teaching aids to improve classroom instruction; analyses of current elementary and secondary level programs; the improvement of communication among professionals in the field; or applied research directed at understanding and improving instruction and learning.

Proposals for workshops may offer to establish guidelines for identifying effective teachers and improving the prestige accorded them; to conduct workshops which offer specialized training; to create workshop materials; to improve the impact of workshops; or to conduct surveys during workshops in order to identify current trends and problems.

The current budget for the materials development program is $12 million; the budget for the workshop program is $2 million.

NSF will evaluate submissions on the basis of the quality of personnel participating in the project, on the inclusion of appropriate contributions from various private and public sectors, on the effectiveness of the internal evaluations built into the project, on the design quality of any proposed products, and on the potential impact the project may have for improving current educational programs.

All proposals should reflect an awareness of the diverse needs of different teacher and student populations. The foundation strongly encourages women and minorities to enter the national competition for these grants.

For more information contact Materials Development (or Honors Workshops) for Precollege Science and Mathematics, Office of Scientific and Engineering Personnel and Education, National Science Foundation, Washington, DC 20550 (telephone: 202-357-7539).

New NAS Journal

In April 1984 the National Academy of Sciences (NAS) will begin publishing a new quarterly focusing on science policy. Written primarily for legislators, diplomats, corporate managers, security analysts, and other public policy analysts, the new journal will deal with such diverse topics as arms control, economic competition, social change, and health care.

Original articles are expected to create a 120-page periodical that will discuss policy issues on a sophisticated but nonspecialist level, in a manner similar to that which *Foreign Affairs* uses to discuss U.S. foreign policy topics, according to NAS.

The National Academy of Engineering and the Institute of Medicine will be copublishers of the journal.

Geophysicists

The following AGU members were elected Fellows of the American Association for the Advancement of Science (AAAS) on May 30: ***Bruce Blanchard, Thomas E. Eastler, Robert L. Fleischer, Hans-Walter Georgii, Neil S. Grigg, Chester W. Newton, Louis C. Pakiser, Jr., Willard J. Pierson, Jr., Malcolm Ross, Harlan J. Smith, Robert L. Smith, Victor D. Vacquier, Joseph Vaverka, Fred N. White, and Charles A. Zraket.***

Larry D. Brown has been elected associate professor of geological sciences at Cornell University. Brown is a co-principal investigator of COCORP (Consortium for Continental Reflection Profiling).

Vernon E. Derr, a physicist and for the past 3 years deputy director of the National Oceanic and Atmospheric Administration's (NOAA) Environmental Research Laboratories (ERL) in Boulder, Colo., has been appointed ERL director, effective last month. He succeeds ***George H. Ludwig***, who resigned from the post in June (*Eos*, July 19, 1983, p. 459). Derr is a specialist in spectroscopy and laser development and application. A pioneer in the use of lasers in studying the properties of clouds and aerosols, his current research focuses on the optical properties of clouds and their effects on climate.

A. Ivan Johnson, a consulting engineer, received the 1983 Frank W. Reinhart Award from the American Society for Testing and Materials (ASTM). He was cited for his leadership on nomenclature for soil and rock mechanics and his work on the development and maintenance of definitions of terms relating to soil and rock mechanics. The Frank W. Reinhart Award is presented by the Society Committee on Terminology to a technical committee, subcommittee, or ASTM member who has made an outstanding and unusual contribution to ASTM in terminology standardization.

A. Ivan Johnson

Clifford Murino was elected president of the University Corporation for Atmospheric Research (UCAR) by the UCAR Board of Trustees. Currently president of the Desert Research Institute of the University of Nevada system, Murino will begin his duties as UCAR president on September 1. He succeeds ***Robert M. White***, the new president of the National Academy of Engineering. Before assuming his University of Nevada post in 1980, Murino had been director of the National Center for Atmospheric Research's (NCAR) atmospheric technology division for 5 years. Before moving to NCAR, he spent 20 years at Saint Louis University in various capacities.

In Memoriam

Eric S. W. Simpson, a leading figure in marine geological and oceanographic research, died in June. A professor at the University of Cape Town in South Africa, he was a former president of the Scientific Committee on Oceanic Research (SCOR) and was chairman of the Commission on Marine Geology of the International Union of Geological Sciences (IUGS). An AGU Life Member and a member of the Tectonophysics section, he joined AGU in 1971.

Nominations for Medals and Awards

William Bowie Medal. Awarded for outstanding contributions to fundamental geophysics and for unselfish cooperation in research.

Maurice Ewing Medal. Honors an individual who has led the way in understanding the physical, geophysical, and geological processes in the ocean; who is a leader in ocean engineering, technology, and instrumentation; or who has given distinguished service to the marine sciences.

Robert E. Horton Medal. Given for outstanding contributions to the geophysical aspects of Hydrology.

James B. Macelwane Awards. Up to three awards are given each year for significant contributions to the geophysical sciences by a young scientist of outstanding ability. Recipients must be less than 36 years old.

Letters of nomination outlining significant contributions and curriculum vitae should be sent directly to the appropriate committee chairmen: *Bowie Medal* - Eugene M. Shoemaker, U.S. Geological Survey, 2255 Gemini Drive, Flagstaff, AZ 86001; *Ewing Medal* - Robert O. Reid, Department of Oceanography, Texas A&M University, College Station, TX 77843; *Horton Medal* - R. Allan Freeze, Department of Geological Sciences, University of British Columbia, Vancouver, B.C., Canada V6T 1W5; *Macelwane Award* - J. Freeman Gilbert, IGPP A-025, University of California/San Diego, La Jolla, CA 92093.

Deadline for Nominations is November 1, 1983.

Books

The Surface of Mars

M. H. Carr, Yale University Press, New Haven, Conn., xiv + 232, 1981, $45.

Reviewed by Peter H. Schultz

Surface features revealed by the Viking Orbiter were 10 times smaller than those recorded by Mariner 9, 30 times smaller than those features seen from Mariners 6 and 7, 300 times smaller than those features in Mariner 4 images, and 15,000 times smaller than our best pre-1964 earth-based views. The book about Mars had to be rewritten following each increase in resolution. Mutch et al. (*The Geology of Mars*, Princeton University Press, Princeton, N.J., 1976) and W. K. Hartmann and O. Raper (*The New Mars*, NASA Spec. Publ. 337, 1974) provided us rewrites following Mariner 9. Carr provides us a comprehensive rewrite following the historic Viking missions.

With the diversity of perspectives possible, Carr focuses on surface features. *The Surface of Mars* may appear to be a geomorphic text, but it is much more than simply descriptions of features. Carr concentrates on the broader implication of features such as their clues for past fluvial activity and evidence for a different paleo-climate. Such implications are not dropped but are used to link different disciplines such as the evolutions of the atmosphere and the interior. Such an approach might seem narrow to some and frustratingly broad to others, but it is a view that permits Carr to pose the most basic questions and to consider first-order answers. He presents a somewhat personal view by no means singular or with tunnel vision. As leader of the Viking Orbiter Imaging Team, he witnessed conflicting and evolving interpretations while the Viking Orbiter relayed new data. Much of this evolution of thought is extensively referenced to current research (up to late 1979), including his own opinion of controversies and judgments. Although some may argue with his opinions, the approach provides a coherence difficult to achieve in group-authored or chapter-authored books. It also serves to focus points of contention, to challenge those with conflicting ideas, and to reveal broad areas remaining to be studied.

Perhaps the greatest strength in this book is the overall clarity of style and methodical approach. He treats Mars as its own planet, much as a terrestrial geologist treats the earth. We are not overwhelmed by terrestrial or lunar analogies, just as a terrestrial geology text is not overwhelmed by lunar or martian analogies. He introduces Mars in a concise overview that describes its surface and processes, thereby familiarizing the newcomer with its place among the inner solar system planets. As greater detail is considered in subsequent chapters, he interjects his own observations and interpretations, which occasionally are lost in the syntheses of other research. But such personal contributions provide a subtle and important thread that holds the book together. This approach, which brings solidity to the book, also brings an occasional impression that the surface of Mars is well understood, an overstatement underscored by the diversity of features and equal diversity of interpretations.

Because Carr has produced a personal view, I have several personal quibbles. The historical perspective provided in the first chapter is adequate but lacks important references and a good view of the pre-1967 observations of Mars. For example, no mention is made of pre-mission conferences such as the results from the 1965 CalTech-JPL Lunar and Planetary Conference or the systematic astronomical studies of Mars such as C. F. Capen's report about the 1964–1965 Mars apparition. Only token reference is made to G. de Vaucouleur's classic text about Mars. Such references are important, not only for a full picture of pre-Mariner efforts but also to instill a certain caution in accepting current "truths" with our present yet still incomplete data sets or parochial viewpoints.

The book is profusely illustrated with Viking images and salient graphs or diagrams from journal articles. In contrast with Mutch et al.'s book, *The Geology of Mars*, however, very few of the nonphotographic illustrations are original. In several instances, sketches or explanatory diagrams could have substantially clarified conflicting interpretations or described processes. Carr provides, nevertheless, a generally coherent discussion of a wealth of facts and concepts. Only occasionally are there lapses in understanding or communication. For example, on page 15 Carr uses the absence of craters in the polar deposits as evidence for recent formation, whereas in fact it indicates active processes that can continuously reshape an old surface. On page 30 he defines "optical depth" for the reader but introduces it on page 27. He presents a somewhat confusing account of the formation of central peaks on page 43, not distinguishing between slope failure (slumping) and plastic flow of the impacted region. He also notes that pits are rare on the moon and Mercury, but such features are certainly common on the moon. On page 52 Carr furthers the idea, based on Mariner 9 images, that extensive mantling has produced the broad featureless regions north of 40°N. The higher resolution Viking images have shown clearly that these regions have a wealth of detail, and the quoted Mariner 9 view largely reflects the effect of haze and oblique viewing angles, a lesson actually learned from Mariners 6 and 7. Carr confuses the accepted usage of the terms impact crater "saturation" and "equilibrium" on page 57, and he switches from incremental crater distributions to cumulative distributions without explanation or warning. On page 70 he implicitly assumes that ridges indicate volcanic plains, but in other sections of the text he clarifies this assumption. In the section on the poles, Carr does not clarify the distinction between the polar cap and the polar layered terrains.

Such nitpicking also applies to editorial and layout errors. For example, upside-down or sideways photographs occur, but are rare. Several misspellings, truncated sentences, and editorial glitches also were found. Although dimensional scales were consistently given for the martian images, ironically they were generally absent from terrestrial photographs. Such criticisms are relatively minor and perhaps stand out only because of the otherwise excellent production.

I found *The Surface of Mars* a stimulating reference that should be on the shelf of anyone wishing a detailed look at the geologic evolution of another planet. But the last word on Mars has not been written. Large quantities of relevant material have been published since 1979 that either are not referenced here or are referenced very incompletely. This is not damning criticism. This is merely testimony that the study of Mars does not simply end at the end of the final mission report. Mike Carr's book provides us a comprehensive status report. It stimulates researchers active in the field both by its synthesis of diverse data and by reaction to his personal views. I am sure this is what he wanted.

Peter H. Schultz is with the Lunar and Planetary Institute, Houston, TX 77058.

The Earth's Climate: Past and Future

M. I. Budyko, *Int. Geophys. Ser.*, vol. 29, Academic, New York, x + 307, pp., 1982, $39.50.

Reviewed by A. Berger

This is not simply another specialized book on climate variations. It is a welcome comprehensive review of the scientific contributions of M. I. Budyko and his colleagues from the Soviet Union.

M. I. Budyko, from the Main Geophysical Observatory in Leningrad, is an outstanding climatologist well known in the field of climate modeling. His results have been published mainly in Russian, but several important papers and books were fortunately published or translated into English. Among them let us remember his *Atlas of the Heat Balance*, *Climate and Life*, and *Climatic Changes*.

Since the 1960's, M. I. Budyko has been very active in research on man's impact on the environment, drawing the conclusion that a drastic change toward warming will occur during the next few decades if modern trends for generating energy continue. As it is now widely believed that anthropogenic climatic change is indeed highly probable, the author thought it was timely to tie together results obtained during the past 10 years. The very last papers are not included, but this is compensated for by a good overview of Russian literature that is usually not available to western scientists.

After a general overview of the more important milestones in climate change research covering both facts and theories, the author discusses the evolution of atmosphere with a special emphasis given to the carbon cycle, stressing the importance of ocean-biosphere-atmosphere interactions. This could have been well described in a flow diagram, but the six-page summary gives a good idea of the main processes responsible for it. This chapter ends with the variations in the chemical composition of the atmosphere on geological time scales dealing especially with carbon dioxide and oxygen and their related effects on living bodies. The two main conclusions are that variations in atmospheric O_2 content definitely influenced the evolution of the animal world, whereas fluctuations in the CO_2 concentration were accompanied by variations in the mass of autotrophic plants and consequently by variations in the total mass of living matter on our planet.

Chapter 5, one of the two more original chapters (the other being chapter 6), focuses on a semi-empirical theory of climatic change. There is an excellent description of the newly improved maps of the heat balance components of the earth-atmosphere system that have been constructed and published in Russian by Budyko et al. in 1978. From the data given in Table 3.2, it can be seen that as the heat balance at the earth's surface improves, the values of absorbed short-wave radiations (40% of the solar constant), of radiation balance (31%), and of heat loss from evaporation (26%) appear to increase by 16–20% and approach the results obtained by Houghton in the 1950's except for the turbulent heat flux.

Taking into account the difficulty of applying more general climate theories to the study of its changes, M. I. Budyko attempts to use for this purpose semi-empirical models, which can be done only at the expense of restricted goals for the model, extensive parameterization of large-scale atmospheric processes, and the use of empirical relationships. Besides his annual model, M. I. Budyko describes extensively a sensitivity analysis of his seasonal model for variations in the solar constant and in CO_2 concentration. Under the title "Unambiguity of Climate," he discusses the stability of his simulated climate, pointing out the stable (e.g., white earth) and unstable glaciation regimes. For example, he concluded (1) that for the existing climate-forming factors, the present-day climate seems not to be unique (that is, a different climatic regime could exist as a new variant of partial glaciation of the earth with a larger area of ice coverage compared with that presently observed) and (2) that an ice-free regime would also take place if the heat income exceeds its present value. Taking into account that these results depend essentially on the albedo parameterization of the earth-atmosphere system with and without snow and ice cover, he derived that relative estimates of a solar constant decrease for various parameterizations of the latitudinal distribution of the albedo, which could cause a glaciation of the earth that lies in the 2–10% interval, whereas the most probable values are 3–5%.

However, the problem of earth's glaciation should be studied further to clear up incompletely solved questions, such as the stationary nature of the climate system and the effect of the changing atmospheric chemical composition (which explains the lack of traces of the earth's complete glaciation during Precambrian times). This is why M. I. Budyko's next chapter is devoted to natural climatic changes. The main interest of the author was deliberately CO_2 and very few pages are devoted to solar variability, astronomical variations of the elements of the earth's orbit, plate tectonics, and internal mechanisms such as cloudy polar ice and other albedo feedbacks.

Although not all geologists or climatologists agree that atmospheric carbon dioxide is the cause of the prevailing changes in temperature of the geological past and/or of the past century, the author stresses the remarkable fit he believes to exist between CO_2 and temperature curves. For most of the earth's early history, its atmosphere probably contained enough CO_2 to maintain fairly high air temperatures near the earth's surface: (1) in the early and middle Phanerozoic (600–300 million years ago), the CO_2 concentration was 6–10 times higher than at present (with a peak around the Devonian-Carboniferous), and the greenhouse effect made up for the lower value of the solar constant; (2) in the late Mesozoic (roughly 100 million years ago) it started to decrease gradually, leading to the Tertiary cooling trend and finally to the Quaternary ice age where astronomical factors started to influence the climate significantly only after the development of polar caps. The post-Pleistocene climatic variations are then presented with a long discussion (38 pages) on the thermal and precipitation regimes variations during the last century. From the Russian works, Budyko concluded that a warming trend began at the end of the 19th century in the extraequatorial latitudes of the northern hemisphere, with a weakly pronounced maximum just before the turn of the century. This was followed by a slight temperature dip, which was soon replaced by a rapid temperature increase. The warming was especially marked during the cold season in the late 1910's and early 1920's. The positive temperature anomaly was greatest at the end of the 1930's; in the 1940's the warming trend was overcome by a cooling trend, which intensified in the 1960's. In the mid-1960's the mean air temperature in the northern hemisphere approached the level of the late 1910's.

Reasons for this present change in climate are then found in volcanic activity and in the atmospheric CO_2 concentration brought by man's economic activity. This is why chapter 5 is totally devoted to the changes in local and global climate induced by man. Budyko's demonstration of the carbon dioxide influence on climate is in general agreement with the scientific works published before the appearance of the Russian version of his book (1980). As a consequence, he did not include the most recent results that the increase in atmospheric CO_2 and its related change in temperature could be much less than was previously thought owing to a reduction in energy consumption and a diversification in energy production. This explains why he still predicts a temperature increase of 0.5°C by the year 2000 and 2.5°C by the year 2025 (and not around 2075 as is now believed) with a northward shift of the growing thermal zones by 1°–3° and by 10°–15° latitude, respectively, in comparison with present-day conditions. Very little is said, however, about early detection strategies of CO_2 climate signal and about the influence of other trace gases, the transient response of the climate, the role of the oceans, and the cloudiness radiation feedback, all factors that can alter the climate response to CO_2 forcing.

The last chapter deals with the distant future of climate and the biosphere. Here it must be pointed out that forward calculation of the astronomical variations points to a new ice age beginning within about 5000 years and not the 10,000–15,000 years mentioned in the book on the basis of an outdated calculation.

Against this background, Budyko's conclusions are that "By using the coal and oil reserves accumulated for hundreds of millions of years, man is restoring the chemical composition of the Late Tertiary period. . . . If this change in natural conditions occurred rather slowly, this process could be favorable for mankind. But the enormous rate of this process creates a number of problems whose solutions can not be so easy. . . . In connection with this, it is necessary to organize, as quickly as possible, broad interdisciplinary investigations of anthropogenic climatic changes and their impact on natural conditions, such studies having to be based on international cooperation."

Although Budyko's book may overemphasize the importance of carbon dioxide among all causes of climatic changes, climatic warming owing to carbon dioxide and other trace gasses nonetheless has to be taken seriously. Budyko has long been actively involved in concern over man's impact on the environment and on climate. His experience made this book a landmark in the development of climatology, and his view on biosphere and climate made it not only important but also of wide interest.

Andre Berger is head of the Institute of Astronomy and Geophysics Georges Lemaitre of the Catholic University of Louvain-la-Neuve, Belgium.

River Basin Planning: Theory and Practice

S. K. Saha and C. J. Barrow (Eds.), Wiley-Interscience, New York, xiii + 357 pp., 1981, $45.50.

Reviewed by Erhard F. Joeres

River Basin Planning is divided into three major parts and an appendix. Part 1, Theory of River Basin Planning, is led by an introductory chapter from the editors emphasizing the major human component in the complex sociotechnical attributes of river basin development. They present a forceful argument for a truly interdisciplinary approach to river basin planning. (The appendix subsequently suggests curriculum development for courses in river basin planning.)

Part 2, River Basin Planning: Environmental Issues, is supported by two chapters: one with a focus on soil conservation, the other on ecosystem protection. The soil conservation chapter by I. Douglas illustrates that allowing, inadvertent changes may be more damaging in the long run than immediate, direct effects. It postulates that planning for people perforce will require planning for soil conservation as an ongoing activity. The case for environmental protection is somewhat weak because of the singular example chosen for illustration. The Gunung Mulu National Park in Sarawak, Malaysia, is in a fragile, humid, tropical forest region where any change per se is interpreted as being detrimental.

Part 3, by far the largest part of the book, is entitled River Basin Planning: Socioeconomic Issues. Its chapters are divided into three general groups. In group one, a number of chapters deal with postdevelopment analyses of a variety of water development schemes. R. P. Lightfoot analyzes the resettlement experience associated with 11 major water development projects in Thailand; R. Winid looks at development achievements in the Awash Valley of Ethiopia; M. J. Shepperdson considers the demographic, environmental, and socioeconomic consequences of the vast irrigation scheme in the Indus River Basin of Pakistan; and E. Street analyzes the role that inexpensive power from the Tennessee Valley Authority has played in the economic, social, and environmental development of that region.

Another group of chapters is methodological, intended either to illustrate possible development scenarios for the future or as pedagogical devices used to train planners in the complex decision processes necessary for water resources planning.

Included in the methodological group is the chapter by L. V. Tavares on a mathematical systems model for a large, multipurpose water resources project currently underway in the Alentejo Region of southern Portugal; the model selects the configuration and temporal and spatial investment sequence possible for the project under given economic assumptions. S. B. Watt presents a critical discussion of socioeconomic issues and their historical relationships for the development on the Senegal River in West Africa; and D. A. Rondinelli presents a role-playing model designed to highlight the necessary sequence of steps to be taken in irrigation planning.

A third group of chapters addresses the difficulty of translating the experience in one place into another, the economic benefits at one time into another, or the perspective of one agency into another. The chapter by A. Blackburn and D. Hughes-Evans discusses the value of comparing different planning approaches as highlighted by management of the Potomac River in the United States and the Thames in the United Kingdom; S. D. Briggs makes a case for ongoing research and development to allow for adjustment and re-evaluation as uncertain socioeconomic parameters manifest themselves through time; and J. M. Sinnn focuses on the problem of vested interests and hidden agendas that surface when two governmental agencies set out to study the same water development scheme in Oyo State, Nigeria.

I found this to be a thoroughly useful book. A collection of papers such as this (17 in all) can always be criticized for varying from the overall scheme of the book. Although there are clearly some problems in this regard, I found the range of material, as well as the applications that have been assembled, quite remarkable. The book illustrates the importance of the many interlocking concerns—behavioral, technical, and environmental—which must be brought into focus if success in planning is to be achieved. Most important, the overriding importance of differing local determinants to the planning process is brought home though the broad range of examples. Although I might want to pick at some individual points, I would recommend the book as a valuable source for its comprehensive coverage. The most likely class application would be in a graduate water-resources planning and management seminar.

Erhard F. Joeres is with the Department of Civil and Environmental Engineering, University of Wisconsin–Madison, Madison, WI 53706.

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Atmospheric Science. A position—up to a three-year term appointment—is available at the Atmospheric Sciences Research Center. The staff member is required to conduct research in one of the Center's areas—cloud physics, cloud chemistry, air pollution, aerosol physics, air-water interface, atmospheric electricity, energy conservation and solar energy. The successful applicant must have a Ph.D. and must have a proven potential as a researcher. Send resume to:

Dr. Raymond A. Castillo
ASRC—Earth Science 324
State University of New York at Albany
1400 Washington Avenue
Albany, New York 12222
An Equal Opportunity Employer.

Tenure-Track Faculty Position-Geophysics/New Mexico State University. We are seeking a faculty member whose duties will include teaching both undergraduate and graduate level courses, conducting research and supervising graduate level thesis and dissertation research. We are particularly interested in a seismologist, but persons with experience in other geophysical techniques are invited to apply.

Minimum qualifications include an earned doctorate in geophysics or a closely related area and demonstrated research capability. Teaching experience and demonstrated ability to secure research funding are desirable. The position is available in January 1984 for 9-month academic year. Appointment will be at the rank of Assistant or Associate Professor. Salary and academic rank will be dependent on experience and qualifications.

Applications and names, addresses and telephone numbers of at least three references should be submitted to Dr. Chandler Swanberg, Department of Earth Sciences, P.O. Box 3AB, Las Cruces, NM 88003.

Applications received by October 15, 1983 will be given preference.

New Mexico State University is an Affirmative Action/Equal Opportunity Employer.

The University of Missouri-Columbia/Faculty Positions. The University of Missouri-Columbia Department of Geology plans immediate expansion through the addition of three tenure-track faculty positions. Appointments are anticipated at the assistant professor level, although higher ranks may be possible, beginning in August of 1984. Candidates will be expected to have completed requirements for the Ph.D. degree by that time. Faculty members are required to provide quality instruction at both undergraduate and graduate level, and conduct research leading to scholarly publications. Successful candidates will be chosen from the following specialties:

Exploration Geophysics
Solid-Earth Geophysics
Hydrogeology
Analytical Structural Geology
Clastic Sedimentology

Applications should send resume, transcripts, and names and addresses of three references to:

Tom Freeman, Chairman
Department of Geology
University of Missouri
Columbia, MO 65211

Structural Geologist/University of Wyoming.

The University of Wyoming, Department of Geology and Geophysics seeks applicants for a tenure track appointment in structural geology to be available beginning fall semester 1984 or earlier. Duties will include teaching at undergraduate and graduate courses in structural geology, supervising MS and PhD theses, and research in structural geology. Appointment at assistant professor level is preferred, but applicants requesting appointment at higher rank will be considered. Applicants must have a PhD degree and be versed in quantitative theory as well as field applications of modern structural geology and regional tectonics.

Applicants should provide a resume, names of three references and a letter of application including a statement of current research interests and courses which the applicant feels qualified to teach. Applications should be sent to: Dr. Robert S. Houston, Department Head, Department of Geology/Geophysics, PO Box 3006 University Station, Laramie, WY 82071.

The University of Wyoming is an equal opportunity/affirmative action employer.

Geophysicist. New Mexico Institute of Mining and Technology invites applications for a tenure track position in exploration seismology at the assistant professor level to begin as soon as possible. The position will be a joint appointment between the College Division and the Research and Development Division. A PhD is required. Send letter of application, resume, brief description of teaching and research interest and names of three references to: Personnel, Brown Hall 17, New Mexico Institute of Mining and Technology, Socorro, NM 87801.

An equal opportunity/affirmative action institution.

Physicist/Computer Professionals. SSAI carries out hardware/software engineering support and physics related modeling studies with NASA/NOAA/NAVY scientists. For our on-going and future anticipated projects, we need Senior Professionals to carry out research, numerical analysis, modeling and simulation studies. These positions require atmospheric scientists with experience in GLOBAL CIRCULATION, STRATOSPHERIC DYNAMICS, PHOTOCHEMISTY, RADIATIVE TRANSFER AND TRANSPORT OR STRATOSPERHIC CONSITUENTS BY MOTION. Professionals with experiences in SOLAR PHYSICS, DIFFERENTIALLY ROTATING STARS, STELLAR STRUCTURE AND EVOLUTION MODELING ARE ALSO NEEDED. Applicants must have MS/PhD degrees and computational experience with large-scale machines and FORTRAN language. SSAI provides a congenial, academic work environment and awards yearly bonuses to all of its employees. Please send your resume with references and salary history to: SCIENCE SYSTEMS AND APPLICATIONS, INC. 1210 Greenbelt Rd., Seabrook, MD 20706.

An Equal Opportunity/Affirmative Action Employer.

Iowa State University of Science and Technology, Department of Earth Sciences. Applications are invited for a tenure track faculty position in Meteorology. Rank is at the assistant or associate professor level, dependent upon qualifications. The successful applicant will be expected to develop a strong research and graduate student program and will teach undergraduate and graduate courses for meteorology majors.

The position is for a person with proven expertise within the general area of dynamic meteorology. Teaching will involve an undergraduate course in synoptic meteorology, in addition to courses related to the field of expertise. Completion of the Ph.D. prior to appointment is strongly preferred. In addition, research ability shown by other publications and/or postdoctoral experience will be an advantage.

Iowa State offers degrees in meteorology through the Ph.D. The program includes about 60 undergraduate majors; the graduate/research program is strong and emphasizes theoretical, dynamic studies. Close relationships are established with the facilities and personnel of major national laboratories. New campus facilities for meteorology are currently under construction.

The appointment is expected to begin no later than September, 1984; an appointment during the current academic year may be possible. Application deadline is November 1, 1983; later applications will be accepted if the position is not filled. For application information please write to:

Dr. Bert E. Nordlie
Department of Earth Sciences
Iowa State University
253 Science I
Ames, Iowa 50011

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Rensselaer Polytechnic Institute/A Tenure-Track Faculty Position and a Post-Doctoral Research Position. The Department of Geology of Rensselaer Polytechnic Institute is seeking applicants for two openings, a tenure-track faculty position and a post-doctoral research position.

The faculty position available in September 1984 requires a Ph.D. or equivalent degree. The area of specialization within the geosciences is open. Particularly important is the applicant's interest in research and teaching at both the undergraduate and graduate levels (M.S. and Ph.D.) with capability to do creative research in the quantitative sciences. Preference will be given to individuals with research experience beyond the Ph.D.; the level of the appointment is open.

The postdoctoral position is available beginning January 1984 to do research in the field of fission track analysis applied to studies of sedimentary basins. Applicants must be knowledgeable and experienced in fission track analysis.

Our present department is part of a modern, technologically-oriented university, and consists of seven members whose collective expertise encompasses structural geology, geophysics, geochemistry, petrology, glacial and surficial geology, and ecological modeling. The RPI environment provides ample opportunities for field and laboratory experimental research in geology, as well as for interdisciplinary studies in chemistry, physics, biology, mathematics, materials science, engineering and computer science.

A resume and the names of three persons who would be willing to provide letters of reference should be sent to: Donald S. Miller, Chairman, Department of Geology, Rensselaer Polytechnic Institute, Troy, NY 12181.

Rensselaer is an Equal Opportunity/Affirmative Action Employer.

Professor and Chairman, Ocean Engineering/University of Miami. Ocean Engineering, with a faculty of nine, is constituted both as a division of the Rosenstiel School of Marine and Atmospheric Science and as a department in the College of Engineering. In addition to performing routine administrative duties, the Chairman is expected to take an active part in teaching and research; qualifications for this post include a record of accomplishments in these areas and an earned doctorate. The Rosenstiel School is embarking on a new five year plan that calls for vigorous growth in the Division. The new Chairman should be capable of fostering and guiding such growth.

Submit applications by January 1, 1984 to: Dr. Joseph M. Prospero, Chairman of the Search Committee, Division of Ocean Engineering, Rosenstiel School of Marine and Atmospheric Science, University of Miami, 4600 Rickenbacker Causeway, Miami, Florida 33149-1098.

The University of Miami is an Equal Opportunity/Affirmative Action Employer.

Groundwater Hydrologist/Jordan Gorrill Associates. The Geotechnical and earth science subsidiary of E.C. Jordan Co., Portland, Maine, has an opening for a senior groundwater hydrologist. Candidates should have an advanced degree in hydrogeology or geotechnical engineering and a minimum of seven years of professional experience. Capabilities and experience in field studies and computer modelling of groundwater flow and solute transport is essential. Client contact experience and good writing skills, including report writing experience, are highly desirable. Position will involve work on solid and hazardous waste projects.

Jordan Gorrill Associates is a nationally recognized geotechnical consulting firm providing a wide range of services in geotechnical engineering, geology, hydrogeology, geophysics, and soil science.

Send resume to: Director of Personnel, Jordan Gorrill Associates, subsidiary of E.C. Jordan Co., 562 Congress St./P.O. Box 7050, Portland, ME 04112, (207) 775-2928.

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University of California, San Diego, A-025
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For further information please write to Doornbos/Husebye (for residents of Africa, Asia or Europe) or Richter/Gilbert (for residents of the Americas, Australia, and New Zealand, and island nations).

Participation will be limited to approximately 80 scientists.

Supervisory Geophysicist. The National Oceanic and Atmospheric Administration (NOAA) announces a Supervisory Geophysicist, GS-15, vacancy in the National Geophysical Data Center, Solid Earth Geophysics Division, Boulder, Colorado. Starting salary at GS-15 level is $34,930. Duties include administrative and technical activities on behalf of the Branch; maintaining liaison with principal geophysicists nationwide; recommending to the Division Chief new techniques and services; serving on national working groups; and providing expert advice. An advanced knowledge of theoretical and practical applications of geophysical data, e.g., gravity, geomagnetism, seismic reflection and related disciplines is required. For further information and/or application procedures, please call Mary Plumley, NOAA Personnel, at (303) 497-5102. Applications must be received by Sept. 23, 1983 to be considered.

An Equal Opportunity Employer.

Professor of Marine Geophysics Tectonics/Stanford University. The Department of Geophysics, Stanford University, is seeking candidates for a tenure track position in the broad area of marine geophysics and tectonics. We seek a creative scientist with experience in gathering, interpreting, and synthesizing marine geophysical data and whose research interests cover depositional, igneous, and tectonic processes on oceanic plates and continental margins. Inquiries are invited from marine geophysicists with demonstrated scientific record in one of the above aspects of marine geophysics or tectonics, who have demonstrated an ability to develop new ideas and research directions, and to guide and teach graduate and undergraduate students. In considering this appointment we are interested in maximizing interactions with ongoing research groups in marine geology, plate tectonics, paleomagnetism, seismology and regional geology at Stanford. Our new faculty member will be expected to develop a strong research program involving both government and industrial participation.

Salary and rank will be commensurate with experience and background. Please submit a resume, a brief description of teaching and research interests, and references to:

Dr. Amos Nur
Department of Geophysics
321 Mitchell Building
Stanford University
Stanford, CA 94305

Stanford University is an equal opportunity employer, and encourages the application of qualified women and minorities.

University of California/Assistant Researcher. Scripps Institution of Oceanography invites applications for the position of Postgraduate Researcher through Assistant Researcher. Appointment as Assistant Researcher requires a publication record.

The position is in the upper ocean physics group of the Marine Physical Laboratory. Active research areas include air sea interaction, internal waves and mixed layer studies, as well as doppler acoustic sensor design. Candidates should have a Ph.D. in Oceanography, Physics or Engineering as well as experience and a desire to participate in field research. Salary range: $15,936 to $26,808 per year. Send curriculum vitae and names of references to Professor Robert Pinkel, Marine Physical Laboratory, Scripps Institution of Oceanography, University of California, San Diego, CA 92152. Closing date: August 31, 1983

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Research Positions/Lunar and Planetary Laboratory. The Lunar and Planetary Laboratory at the University of Arizona has research positions open for Research Scientists. Researchers in the Laboratory have access to the University's observatories, a complete collection of planetary images, computers and laboratory facilities. The research ranks in the Laboratory, namely Assistant Research Scientist, Associate Research Scientist, and Research Scientist parallel the tenure track ranks of Assistant, Associate and Full Professor. Salary levels are commensurate with equivalent tenure-track ranks. These are not tenurable and not state-funded positions. Researchers in these positions will be expected to supply a significant portion or all of their salaries through their grants and contracts.

Applicants should submit a curriculum vita, list of publications, and the names of three references by November 1, 1983, to L.A. Wilkening, Director, Lunar and Planetary Laboratory, University of Arizona, Tucson, AZ 85721.

The University of Arizona is an Equal Opportunity Employer.

Hydrogeologist, Hydrologist, or Water Resources Planner. The Kansas Geological Survey, a division of The University of Kansas, solicits applications for a hydrogeologist, hydrologist, or water resources planner. Permanent, full-time position subject to annual review. Salary Range: $20,000–$30,000 per year, depending on qualifications. Required qualifications: Master's degree in hydrogeology, hydrology, or related water resources field. Course work in theoretical hydrologic modeling and capability to apply these models to different hydrologic and water planning problems to particular areas in Kansas. Preferred qualifications: Ph.D. degree in one of the above fields, and 2–3 years of research experience in water resources related studies.

Freedom to conduct research within the framework of the KGS Geohydrology Section's program and support of a university environment. Opportunity for graduate student teaching and fully funded research opportunities in excellent research facilities.

Contact Personnel Manager, Kansas Geological Survey, 1930 Constant Avenue, Campus West, The University of Kansas, Lawrence, Kansas 66044 (913/864-3965) for full position description, or to apply, send resume, college transcripts, list of published research, and three letters of reference. Inquiry will be given to applications received by October 31, 1983. Applications will be accepted and reviewed every thirty days thereafter until the position is filled.

AN EQUAL OPPORTUNITY/AFFIRMATIVE ACTION EMPLOYER.

Research Associate/Petrography-Petrology. To join a research effort aimed at understanding the condensation history of the solar system by mineralogical, chemical, and isotopic studies of tiny inclusions in primitive meteorites. Applicant need not necessarily have petrographic experience, but must have previous experience with meteorites and should be a superb petrographer, skilled in the use of the SEM and electron probe. Successful candidate will be dedicated, productive, an effective communicator both orally and in writing, and will have a Ph.D. in hand. Vacancy expected by mid autumn 1983.

Send resume and names of three references to L. Grossman, Department of the Geophysical Sciences, University of Chicago, 5734 S. Ellis Avenue, Chicago, IL 60637.

The University of Chicago is an Equal Opportunity/Affirmative Action Employer.

Support Scientist I/II/The National Center for Atmospheric Research in Boulder, Colorado. Recruiting for Support Scientist I and II for the Convective Storms Division. Mesoscale Interactions Group. DUTIES: Assist in the analysis and interpretation of radar, aircraft, and mesonet data from the surface to the troposphere, in the study of the origin and evolution of deep convective systems, in the mid-latitudes and the tropics and their interaction with motions of larger and smaller scales. ADDITIONAL RESPONSIBILITIES FOR LEVEL II: participates in all phases of research; considerable responsibility for writing up results for publication; develops and modifies computer programs; may participate in planning and execution of field experiments including the planned field phase of the Stormscale Operational and Research Meteorology (STORM) project; manages computers in ways consistent with UCAR policies and procedures and Affirmative Action program goals. REQUIRES:

- Master's degree in the atmospheric sciences with a thesis on a topic related to the above topics or demonstrable equivalent of expertise and interest.
- Working knowledge of techniques in at least one or more of the following areas:
- Demonstrated skill in writing and modifying complex computer programs for data analysis including manipulation of magnetic tape, I/O, and sub-routines.
- Demonstrated skill in planning and coordinating required research.
- Demonstrated skill in writing up research results.
- Demonstrated skill in meeting deadlines and organizing workload.

ADDITIONAL REQUIREMENTS (Level II):

- Demonstrated skill in working independently. This position is for a one-year term with possibility of extension.

Salary: $17,020–$26,800/year LEVEL I; $21,516–$32,268/year LEVEL II

Send resume promptly to Esther Bloom, National Center for Atmospheric Research, PO Box 3000, Boulder, Colorado 80307, or call (303) 494-5151, Ext. 581 or 666 for further information.

An Equal Opportunity Employer.

University of Minnesota Stratigrapher/Sedimentary Petrologist. Tenure-track position starting Fall 1984, probably at the Assistant Professor level. The candidate must have a Ph.D. with interest in stratigraphy of sedimentary basins, tectonics and sedimentation, and sedimentary petrology, and will be expected to carry out research and to teach graduate and undergraduate courses in these fields. Please submit resume, academic records, and three letters of recommendation to Dr. Peter J. Hudleston, Department of Geology and Geophysics, 108 Pillsbury Hall, University of Minnesota, Minneapolis, MN 55455 (612/373-3873.

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Marine Organic Chemist. Research Associate in the Cooperative Institute of Marine and Atmospheric Sciences, University of Miami and National Oceanic and Atmospheric Administration. Experience in GC-MS-DS and sampling from ships or aircraft desired. M.S. preferred. Contact Chairman Search Committee, D.R. Atwood, NOAA/AOML, 4301 Rickenbacker Causeway, Miami, Florida 33149.

An Equal Opportunity Employer.

SCIENTIST I/II-National Center for Atmospheric Research/Boulder, Colorado. The National Center for Atmospheric Research in Boulder, Colorado is recruiting for Scientist I and II for the Convective Storms Division-Mesoscale Interaction Group. DUTIES: Carries out individual and collaborative research on small to mesoscale meteorology. Projects will be selected and defined in collaboration with the senior staff. Scientific effort will focus on the structure and dynamics of convective flows and other mesoscale systems, thunderstorm initiation, hurricanes, interactions among turbulence, convection, mesoscale, and synoptic scales. Emphasis is on observational studies using data from surface mesonets, tethered balloons, aircraft, and Doppler radars. Actively participates at scientific meetings; makes contributions to professional journals and other literature; may participate in planning and execution of the Stormscale Operational and Research Meteorology (STORM) field experiments and other field programs; develops an understanding of mesoscale systems that will enhance accurate forecasting; interacts with scientists within NCAR and elsewhere to achieve individual and group scientific objectives; manages employees in ways consistent with UCAR policies and procedures and Affirmative Action program goals. REQUIRES:

- Ph.D. dissertation or equivalent evidence of independent research contribution in meteorology or closely allied field
- Demonstrated skill and creativity in analysis/interpretation of data from one or more of the data systems listed above with a realistic idea of their limitations
- Demonstrated skill in oral and written presentation of scientific results
- Ability to write and modify complex computer programs for data analysis

ADDITIONAL REQUIREMENTS FOR LEVEL II:

- Several years of productive research experience as indicated by number and quality of publications, or equivalent evidence.
- Demonstrated skill in the above areas

NOTE: Scientist I and II appointments are for terms of up to three and four years respectively. Individuals may be appointed to the next higher level of Scientist in accordance with the UCAR Scientific Appointments Policy.

SALARY: $25,814—$38,722 LEVEL I, $30,077—$46,668 LEVEL II

Send resume promptly to Esther Bloom, National Center for Atmospheric Research, PO Box 3000 Boulder, Colorado 80307, or call (303) 494-5151, Ext. 581 or 666 for further information.

Equal Opportunity/Affirmative Action Employer.

Scientist I/the National Center for Atmospheric Research. NCAR is seeking a Scientist I for the Acid Deposition Modeling Project.

DUTIES: Will develop computer programs for the simulation of chemical interaction within the ADM system and engage in related independent research.

REQUIRES:

- Ph.D. or equivalent experience and education
- Considerable knowledge of tropospheric chemistry
- Knowledge of atmospheric chemistry modeling, atmospheric scavenging processes, physics of rain/gas/acid deposition, and computer programming.

NOTE: Scientist I appointments are for terms of up to three years. Individuals may be appointed to the next higher level of Scientist in accordance with the UCAR Scientific Appointment policy.

Salary: $25,814—$38,722/year

To apply: please send resume or call Margarita Boscoli at (303) 494-5151, ext 517 for information and application. NATIONAL CENTER FOR ATMOSPHERIC RESEARCH, PO Box 3000, Boulder, CO 80307. Equal Opportunity/Affirmative Action Employer.

Chairman—Department of Geological Sciences, Wright State University. The Department of Geological Sciences invites applications for the position of chairman, to be appointed September 1984. We seek a dynamic individual with administrative talent and an appreciation for research and practice-related educational activities. Rank is at the full professor level and no restrictions have been placed on areas of specialization. The department is active with 18 faculty and an emphasis on professional practice, yet maintaining a firm commitment to basic research.

Send a letter of application, curriculum vitae and names of three references to:

Chairman, Search Committee
Department of Geological Sciences
Wright State University
Dayton, OH 45435.

SERVICES, SUPPLIES, COURSES, AND ANNOUNCEMENTS

XVIII INTERNATIONAL COURSE IN GROUNDWATER HYDROLOGY. Sponsored by the Polytechnical University of Barcelona, the Eastern Pyrenees Water Authority, the Public Works Geological Service, the Hydrographic Confederation of the Eastern Pyrenees, the Spanish Foreign Office, the Generalitat of Catalonia, the Water General Society of Barcelona and the Public Works Study, and Experimentation Center. This course will be held in Barcelona from June 18 to July 15 1984. It will be mainly intended for graduated students in geological sciences and science faculties who wish to receive further training or specialization in the problems of prospecting, use, administration and planning of groundwater while studying surface water and other hydrological resources.

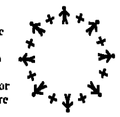
The teaching program will be: auxiliary disciplines, groundwater exploration and exploitation, and water management. There will be a total of 811 field trips, 7 technical visits, and a ground-water practical report. Lectures will be given in Spanish.

For further information, please write to: Curso Internacional de Hidrologia Subterranea, Beethoven, no 15-30, Barcelona-21 (Spain), Telephone (93) 322-19-81, Telex 52455 COABNE.

AGU

Top Sponsors

One thousand, one hundred, and ninety-five new members have been elected through July 31, 1983. The top sponsors, AGU members sponsoring three or more new members, are listed below.



Eight Members Robert T. Hodgson.

Seven Members Erwin Seibel.

Six Members Harold H. Demarest, Jr., Karyn Masconi, Paul E. Myers.

Five Members John A. Dracup, Kazuya Fujita, Robert B. Smith.

Four Members Laurie Brown, Robert L. DuBois, John J. Gallagher, Jr., Louis J. Gordon, Carl Kisslinger, L. A. Kivioja, Christopher N. K. Mooers, Charles G. Sammis, A. F. Spilhaus, Jr., William J. Teague.

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Membership Applications Received

Applications for membership have been received from the following individuals. The letter after the name denotes the proposed primary section affiliation.

Frank W. Bergstrom (H), John A. Best (S), Lawson W. Brigham (O), Jan Olof Burgman (H), Dominique Burrus, John S. C. Curran (G), Daniel Davies (P), Michael P. Dumont (O), Gerald R. Garrison (O), Varut T. Guvanasen (H), Ross N. Hollman (A), Boone Jones, Lubicho L. Kostov (H), Paul Lagace, James M. Lattimer (SS), Duncan T. Mackenzie (S), Franz X. Meixner (A), Jacques Merle (O), Kichang Na (V), Alan E. Ruffy (G), Susan L. Russell-Robinson (V), Rock Santerre (G), Minoru Sasaki (G), Bernard Shizgal, Don Vroblesky (H), Craig B. Wall (P), Julia A. Watts (A), Crayton Yapp (V).

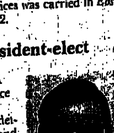
Student Status

Jeffrey Alexander (O), Sang Keun Bae (H), Ronald L. Biegel (S), David A. Boness (S), Robert S. Borch (V), Eric J. Brown (S), Randie E. Cabeen (H), Diane H. Carlson (V), Everett F. Carter (O), David Dahl (V), Gene M. Davis (V), Edward F. Duke (V), Cheryl Lyn Dybas (O), Tracy Eanes (O), David Graham (V), Joseph Ha (S), Remy Hennet (V), Katherine Hirschbeck (H), Austin Imiensewarin (GP), Todd Allen King (S), Michael Leonard (S), Ellen Lettvin, Gad Levy (A), Stanley D. Locker (O), Subhashis Mallick (S), Teruyuki Matsui (T), Michael McKibben (V), Herbert W. S. McQueen (T), Javier J. Meneses-Rocha (T), David J. Mulla (H), Patrick M. Okita (V), Carol Prentice (T), Margaret P. Ricci (S), Daniel Rosenblatt, Daniel Rothman (S), J. Michael Ruohoniemi (SA), Bradford Sherman (H), Yan Song (V), Stephen W. Todoroff (O), E. A. Vaverka (GP), Richard Wagener (P), E. Timothy Wallin (GP), Eldean M. Ward (T), Douglas A. Wolf (V).

Union and Section Candidates

In the coming months *Eos* will carry biographies and photographs of all candidates for President-elect, General Secretary, and Foreign Secretary of the Union and for President-elect and Secretary of each Section. In addition, announcements by the candidates for Union offices and Section President-elect will appear. The material for the Geodesy, Geomagnetism and Paleomagnetism, and Planetology sections appears below. The slate of candidates for all offices was carried in *Eos*, June 21, 1983, p. 422.

Geodesy: President-elect



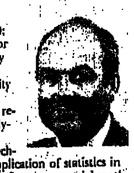
John D. Bossler A member of AGU since 1972; 46 years old; Chief, National Geodetic Survey, Charting and Geodetic Services, National Ocean Service, National Oceanic and Atmospheric and Administration (NOAA) of the Department of Commerce; Major Interests: Geodetic Science and Surveying. B.S. in Civil Engineering, University of Pittsburgh (1959); M.S. in Geodetic Science, Ohio State University; was concurrently Project Manager for the New Adjustment of the North American Horizontal Geodetic Datum and Deputy Director, National Geodetic Survey. His scientific experience includes developing algorithms and computer programs and performing research in support of various projects in geodesy and geodynamics. Vice President, American Congress on Surveying and Mapping; Secretary, AGU Geodesy Section; Past Chairman, American Society of Civil Engineers, Executive Committee of the Surveying and Mapping Division: Secretary, Section I (Control Surveys), International Association of Geodesy; Member, U.S. National Committe of the International Union of Geodesy and Committee on Geodesy; 30 publications, 3 published by AGU. Recipient of two Heiskanen Awards of Ohio State University and recipient of the 1982 Department of Commerce Gold Medal (the Department's highest award). Past Associate Editor, *Journal of Geophysical Research*.

Statement

"Geodesy lies at the center of a spectrum of technical disciplines ranging from ones that emphasize geometry, like cartography, surveying and photogrammetry, to those that are based on physics, like oceanography and tectonophysics. This central focus means that geodesy is well positioned to influence (and be influenced by) a most diverse group of scientific fields. As part of AGU, the Geodesy Section has tended to concentrate on the physical side. In recent years, this interaction has proved very fruitful, because increasingly precise geodetic measurements and techniques have shed much light on significant areas of geophysical research. I believe that geodesy should and will continue to serve as a productive source of information for the rest of geophysics. Therefore, I would push for closer and more formal cooperation between the Geodesy Section and other AGU sections in setting up AGU meeting programs, special symposia, and in AGU publications, e.g., the Seasat special issues of JGR. We should combine sessions and develop specialty conferences with other sections to further strengthen these ties.

"But I would also stress that the Geodesy Section must not neglect its relationships on the geometric side. The new, precise positioning techniques—GPS, VLBI, laser ranging, and inertial positioning—not only yield valuable geodynamical information, but also provide surveyors with tools that can revolutionize their profession. The Geodesy Section must be holistic in its attitude and embrace all the disciplines within its purview. We must enlarge our contact with kindred societies like the American Congress on Surveying and Mapping and the American Society of Photogrammetry. Furthermore, we should strive to influence educational institutions to combine courses which relate to these various aspects of geodesy but are usually widely separated departmentally. I would see to it that AGU actively sponsors or cosponsors meetings and symposia featuring geometric geodesy and geodetic instrumentation. Thus, I maintain that geodesy must develop in both directions—physical and geometric—and that such development will optimally benefit our profession and the scientific community in general.

"I am particularly concerned that geodesy not lose sight of the fact that it is a science in its own right, and not just a service to other sciences. The fundamental geodetic objectives—to determine positional relationships and the gravity field—remain unchanged and continue to be interesting and important areas for scientific investigations. Geodetic research will maintain its usefulness for other sciences, but those who engage in this research are first and foremost geodesists and should be proud to wear the title."



Petr Vaníček Member since 1970; 47 years old; Professor of geodesy, University of Toronto (Erindale College) and University of New Brunswick, Fredericton. Current research interests: geodynamics, earth gravity field, mathematical techniques of geodesy, application of statistics in geodesy, applications of extraterrestrial methods to geodesy, physical oceanography, theoretical elasticity. Received Dipl. Ing. degree in geodesy (1959) from the Czech Technical University, Prague, and Ph.D. in mathematical physics (1968) from the Czechoslovak Academy of Sciences, Prague. Worked as a surveyor at Prague Institute of Surveying and Cartography (1959–1963); consultant in numerical analysis and computer applications at Faculty of Technical and Nuclear Physics of Czech Technical University (1963–1967); research fellow and later senior scientific officer at Institute of Oceanography, Bidston, UK (1967–1969); NRC of Canada postdoctoral fellow in Surveys and Mapping Branch of EMR, Ottawa (1969–1971); associate and full professor of geodesy at UNB (1971–1983); visiting scientist, USGS Center for Earthquake Research, Menlo Park, California (1977). Currently: member of executive CGU; fellow of GAC; Sigma Xi; member of CIS, NYAS, SVU; member of Canadian National Committee for IUGG; Committee on Geodesy of NAS-NRC. Author of 140 books and papers including 3 papers in *Eos* (e.g., "The map of contemporary vertical crustal movements in Canada," with D. Nagy) and one in *Reviews of Geophysics and Space Physics* ("Geodetic levelling and its applications," with R. O. Castle and E. I. Balazs). Co-editor of *Manuscripta Geodaetica*. Member of the IAG working group nos. 1:21, 1:41, 4:60, 5:63. Canadian representative on IUGG Committee on Recent Crustal Movements. Honors include: NERC (UK) Senior Research Fellowship (1967–1969); NRC (Canada) Postdoctorate Fellowship (1969–1971); CNPq (Brazil) Visiting Professorship (summers 1975, 1976, 1979); NRC (USA) Senior Visiting Scientist (1978); University of Stuttgart (W. Germany) Visiting Professorship (summers 1981, 1982); University of São Paulo (Brazil) Visiting Professorship (summer 1981). 1978 to 1981 served on AGU GMP Committee.

Statement

"North American geodesy has been suffering from a lack of identity. This continent has seen some of the most spectacular geodetic achievements; yet, often enough these were born under the auspices of space science, tectonophysics, oceanography, etc. Some of my more pragmatic colleagues will argue that there is nothing wrong with this, "throw out plurality." I feel, however, that the cause of science would be better served if geodesy were, once more, recognized for what it is: a scientific discipline in its own right.

"Geodesy is the discipline that concerns itself with the geometry of the earth and its gravity field, including the temporal variation thereof. Thus geodesy is as much a part of geophysics as geometry is a part of physics. It is on these philosophical foundations that the Geodesy Section should cooperate with the other sections of AGU. It is this position that the Geodesy Section should take when asking itself: What is there that the geodesy can do for the other disciplines and what is there the other disciplines can do for geodesy? It is this point of view that I should adopt if elected to the presidency.

"On a more down-to-earth level, the Section may consider doing more for the promotion of AGU among professional colleagues and students alike. The promotion should include soliciting research papers as well as review papers for JGR and RGSP, and soliciting manuscripts for publication in the AGU Geophysical Monograph Series. As an example of other possibilities, the Section may consider launching a campaign to evaluate geodetic content in various pertinent university programs on this continent and publish the results.

"To conclude, I should like to thank the Nominations Committee for the honor bestowed upon me by having nominated me even though I am not a U.S. citizen."

Geodesy: Secretary

William E. Carter A member of AGU since 1980; 43 years old; Chief of the Advanced Technology Section, Geodetic Research and Development Laboratory and VLBI Project Manager, National Geodetic Survey. Major interest: the application of advanced technology to geodetic surveying for research in geodynamics, e.g., the use of Very Long Baseline Interferometry and Lunar Laser Ranging to study polar motion, earth rotation, and motions and deformations of the lithospheric plates. B.S. in Civil Engineering, University of Pittsburgh, 1961; M.S. in Geodetic Science, Ohio State University, 1965; Ph.D. in Civil Engineering, University of Arizona, 1973. Geodetic Officer in U.S. Air Force, 1961–1969; Research Geodesist, Air Force Cambridge Research Laboratory Lunar Laser Ranging Observatory 1969–1973; Research Associate and Head of the Lunar Laser Ranging Observatory, University of Hawaii, 1973–1976; National Geodetic Survey, 1976–present. Member of IUGG; President of IAG SSG 2.51 on Radio Interferometry; Member Steering Committee of Commission VIII on International Coordination of Space Techniques for Geodesy and Geodynamics; Member of IAU; Principal Coordinator of VLBI on MERIT Steering Committee; Member AAS. 40 publications, 5 published by AGU, including "Frequency modulation of the chandlerian component of polar motion," and "Refinements of the polar motion frequency modulation hypothesis."

AGU (cont. on p. 528)

AGU (cont. from p. 527)

James G. Marsh A member of AGU since 1971. Employed in the Geodynamics Branch, Goddard Space Flight Center, since 1964. Major interests: precision orbit determination, geodetic parameter estimation, and applications of satellite altimeter data to the determination of mesoscale and global circulation. Received NASA Exceptional Service Medal in 1980. Published over 70 papers. M.S. in Physics, West Virginia University 1963.

Geomagnetism and Paleomagnetism: President-elect

Subir K. Banerjee A member of AGU since 1967; 45 years old; Professor of Geophysics, University of Minnesota, Minneapolis. Major interests: geomagnetism, paleomagnetism, rock magnetism, and history of medieval science. B.Sc. in physics, Calcutta University, 1956; M. Tech in exploration geophysics, Indian Institute of Technology, Kharagpur, 1959; Ph.D. in geophysics, Cambridge University, 1963. Senior Research Associate and lecturer in geophysics, University of Newcastle-upon-Tyne, UK, 1964–1969; Senior Staff Scientist, Franklin Institute Research Laboratories, Philadelphia, 1969–1971; Associate Professor of Geophysics, University of Minnesota, Minneapolis, 1971–1974; Professor of Geophysics at Minnesota since 1974. Adjunct Professor of Middle Eastern and Islamic Studies at Minnesota since 1976. Visiting Professor at different times at Osmania University, India, Stanford University, and University of California, Berkeley. Visiting Scholar, Office for History of Science and Technology, University of California, Berkeley, 1977–1978. Past member of Institute of Physics, UK and European Physical Society. Editorial Board: Quaternary Research, 1978–1980. Past member, U.S. Geodynamics Committee, Working Group on paleomagnetism; Vice-Chairman and U.S. representative in International Association of Geomagnetism and Aeronomy, Working Group on rock magnetism, 1975–1979; NRC-NAS Study Panel on Impact of Technology on Geophysics; Member, Program Committee for USGS Workshop on Geomagnetism, 1982; 90 publications, 12 published by AGU; author of *Physical Principles of Rock Magnetism* (with F. D. Stacey); Sc. D., Cambridge University; listed in Who's Who in America, and American Men and Women in Science; served as Associate Editor, *Journal of Geophysical Research* Red, and *Reviews of Geophysics and Space Physics*; presently a member of the AGU Committee on the History of Geophysics; Program Chairman, Geomagnetism and Paleomagnetism section, 1983 AGU Fall Meeting.

Statement

"I thank the nominating committee for the opportunity to be considered as one of the candidates for the presidency of the section. The president of the GP section has a two-fold responsibility: first, toward the membership at large, and second, to the AGU Council by acting as a two-way channel for communications. I propose to pursue vigorously both of these activities, some by continuing the excellent approaches initiated by the present president and president-elect and by initiating a few of my own.

"The membership at large has justifiably been concerned by the splitting of the national meetings into two de facto regional meetings. In 1968, the year when GP was created as an autonomous section, there were 61 papers delivered at the spring meeting and 11 at the fall meeting. In 1982 these numbers were 59 and 112, respectively! It is hard to buck the sentiment of the membership "voting with their feet," but it is well within our capability to work with the two section program chairpersons so that special sessions of broad national interest are alternated between the two meetings and to schedule occasional workshops of broad interest in the membership at large (such as the Rock Magnetism Workshop that I have arranged for the 1983 Fall Meeting). In this connection, if elected, I propose to use vigorously the topical Chapman conferences to bring together smaller groups of workers in GP section with similar or complementary interests, as was done at the 1982 USGS Workshop on Geomagnetism in Golden, Colorado.

"A second service to members is through the journals program. Following the lead of the Ocean Sciences Section, and now the Volcanology, Geochemistry, and Petrology section, I propose to publish in *Eos* from time to time a GP newsletter which will inform the membership about new researches, funding sources, instrumental developments, and, above all, about mechanisms to keep in close touch workers in electromagnetic induction studies, main field studies, paleomagnetism, and rock magnetism. Another area where I could be of service to GP members is by cooperating with the new editors of GRL and RGSP so as to increase the present minuscule percentage of articles dealing with geomagnetism and paleomagnetism in these journals.

"There has always been a conscious effort to involve "new blood" in participating in the GP section affairs, and I myself have been a beneficiary of this in the past. I propose to pursue this tradition thoroughly be it by inviting contributions from new authors for the IUGG Quadrennial Report, or by nominating new faces as conveners for special sessions at the national meetings, and especially by making sure that an ever-increasing number of younger workers are given travel grants to attend IAGA and IUGG assemblies.

"If I am able to carry out at least some of the above initiatives and inform the AGU Council accordingly, our voice in the Council will be heard loud and clear. In addition, I will also seek out membership concerns about the AGU as a whole, to be voiced at the Council meetings, and cooperate with the other section presidents for the furtherance of the goals of AGU."

D. Ian Gough A member of AGU since 1964; age 60; Professor of Physics, University of Alberta. Major interests: solid earth geophysics and tectonics, with emphasis on electromagnetic induction in earth and its use in delineating tectonically significant structures; paleomagnetism; induced seismicity and lithosphere stress. B.Sc. in physics and mathematics, Rhodes University, South Africa, 1943; M.Sc., 1947; Ph.D., University of Witwatersrand, 1953. South African National Physical Research Laboratory 1947–1958; University College of Rhodesia and Nyasaland 1958–1963; Southwest Center for Advanced Studies, Dallas 1964–1966; University of Alberta, professor from 1966, Director, Institute of Earth and Planetary Physics, 1975–1980. Fellow: Royal Society of Canada, AGU, Royal Astronomical Society, Geological Association of Canada; Hugh Kelly Fellow, Rhodes University, 1947; Visiting Fellow, Churchill College, Cambridge, UK 1978. Former President, CGU. Has served on numerous Canadian national committees, currently member of Canadian National Committee for the International Lithosphere Program and of Lithoprobe Steering Committee. Chairman, Division I, IAGA. 80 publications, 13 published by AGU. Formerly Associate Editor, JGR; on editorial boards of *Journal of Geomagnetism and Geoelectricity, Physics and Chemistry of the Earth, Journal of Geodynamics*.

Statement

"A prospective president of a section of AGU must be able to arrange timely sessions and workshops on topics in which the science is advancing. I must tell you how I see Geomagnetism and Paleomagnetism at this time, so that you may judge whether I might be an adequate president of the GP Section.

"The description of the geomagnetic field has recently made great strides by means of satellite data for the latitude range 30°N to 30°S. The development of periodically updated international geomagnetic reference fields both improves the data base for workers on the core field and facilitates good maps of the crustal anomaly field. In high latitudes both steady and transient currents in the magnetosphere and ionosphere can be studied by satellites in polar orbits, but obscure the internal field from the core and crust. High latitude satellite magnetic data thus present difficult problems but certainly contain information of great value.

"For those working on the core dynamo problem I think interaction with paleomagnetists is important. Paleomagnetic data have shown that the core field has been dominantly dipolar through the last 500 my and confront the dynamo theorists with aperiodic reversals. Data for the field during a reversal are vital but few. Intensity data are now accumulating and give further input to the dynamo problem. The paleomagnetists themselves are increasingly studying the geomagnetic field rather than plate kinematics. In addition to finding paleo-intensities they are using recent sediments, from lakes in particular, to investigate the nondipole field over the last few millenia. In hard-rock paleomagnetism the correct separation of multiple components of remanent magnetization presents a problem. For precambrian rocks accurate dating and definition of the paleohorizontal are problems often harder than the paleomagnetic measurements themselves.

"Those concerned with the use of electromagnetic induction to show conductive structure confront ever-increasing data but no matching advance in inversion techniques. The combination of magnetometer arrays with magnetotellurics is being tried and may prove fruitful. Various artificial sources of magnetic fields are in use and will simplify inversion. Ocean-floor data are beginning to open new opportunities. Even without quantitative modeling, electromagnetic data often reveal and locate structures of geotectonic significance.

"In the era of interplanetary vehicles, magnetic field data from other planets must fascinate us all. AGU will undoubtedly continue a leading role in the study of the magnetospheres of the Jovian planets in conjunction with that of the earth. Work on the solar wind and magnetic field, and their interaction with planetary magnetospheres, is active and important.

"These are some fields in which I see growth at the present time. My list is certainly incomplete. If your field is unmentioned or travestied and I am elected, it will be up to you to make good the gap in my education."

Geomagnetism and Paleomagnetism: Secretary

John W. Hillhouse A member of AGU since 1972; 54 years old; geophysicist, U. S. Geological Survey. Major interests: paleomagnetism, solid earth geophysics, and plate tectonics. A.B. in geology and geophysics, University of California, Berkeley, 1971; Ph.D. in geophysics, Stanford, 1975. With USGS since 1974. Member: AGU, GSA; 15 publications, 9 published by AGU. Phi Beta Kappa. Served as Fall Meeting program chairman of GP section; associate editor of JGR red.

John L. LaBrecque A member of AGU since 1973; 36 years old. Presently a Senior Research Associate at the Lamont-Doherty Geological Observatory and a member of the Columbia University Faculty. Received his B.S. from the Columbia School of Engineering in 1969, M.Ph. and Ph.d. from Columbia in marine geophysics in 1973 and 1977 respectively. In 1981 served as research associate at the Laboratorio di Geologia Marina of the Italian CNR at Bologna. Has over 22 publications, which include studies of the geomagnetic reversal history, the South Atlantic, Indo-Atlantic and Red Sea Basins, investigations of intermediate wavelength magnetic anomalies over the North Pacific, and the development of passive continental margins. Has served the DSDP both as a member of the Southwest Atlantic working group and a co-chief scientist aboard Leg 73 of the Glomar Challenger during an extremely successful application of HPC technology to magnetostratigraphy. Currently conducting active research in the geologic implications of intermediate wavelength magnetic anomalies, in Arctic and South Atlantic plate kinematics, and the magnetic anomaly patterns over transition zones at passive continental margins. Also active in areas of satellite data analysis including the NAVSTAR, MAGSAT, and SEASAT data sets.

Planetology: President-elect

Michael H. Carr A member of AGU since 1965; 47 years old; Geologist with the U.S. Geological Survey. Major interests: general geology of the planets; planetary volcanism; history of fluvial processes and volatiles on Mars. B.Sc. in geology, University College, London, 1956; Ph.D. in geology, Yale University, 1960. Research associate, University of Western Ontario, 1960–1962; with the U.S. Geological Survey since 1962; Chief, Branch of Astrogeologic Studies, 1974–1978. Member AGU, GSA, AAAS. 85 publications, 14 published by AGU; author of *The Surface of Mars* published by Yale University Press. Served on several advisory committees to NASA: Lunar and Planetary Review Panel; Planetary Geology Review Panel, Planetary Geology Working Roup, NAS-Committee for Planetary Exploration. Leader Viking Orbiter Imaging Team; member Mariner 9, Voyager, and Galileo science teams. Associate editor *Icarus*, associate editor JGR Red. NASA medal for Exceptional Scientific Achievement, 1977; Department of Interior Meritorious Service Award, 1980.

Statement

"The last few years have been both exhilarating and discouraging for planetary science. Missions to Venus, Mars, Jupiter, and Saturn have been spectacularly successful, but funding for research and analysis has declined, and new missions, the lifeblood of the science, have been difficult to initiate. The rate of acquisition of new data has slowed considerably and will remain at a low level for at least 5 years. However the outlook now appears to be changing. The long decline in research funding has been arrested, if not reversed, and a new philosophy for design of planetary missions, outlined by NASA's Solar System Exploration Committee, has led to optimism about the feasibility of sustaining a sound program of scientific exploration of the planets despite tight fiscal constraints. This optimism appears justified in view of recent approval of a Venus Radar Mapper mission and supplements to NASA's planetary exploration budget.

"These developments have several implications for the Planetology Section of AGU. The pause in data taking should lead to a maturation of the science. For most planetary bodies the reconnaissance has been done and the initial, quick interpretations have been made. Now is the time for consolidation, for integration of the results from different disciplines, and for a more thorough and exhaustive analysis of the data in hand. Such a period of reassessment is not only desirable for the health of the science but is also necessary for a balanced, ongoing exploration program. Because of the fiscal constraints, future missions will probably be much more narrowly focused than past missions. They will tend to address a limited number of specific problems rather than the science of a planet as a whole. We then must be in a position to judge which are the most pressing problems and what measurements must need to be made. AGU, being the major multidisciplinary organization for planetary scientists, can play a significant role in this process of maturation, and that role should be promoting the highest possible standards for planetary science. Ways that this might be effected are by maintaining the traditionally high standards of publication in AGU, by holding at AGU meetings multidisciplinary sessions on various topics of broad interest, and by providing a forum for presenting the results of planetary science to the general scientific community. AGU has recently started to play a larger role in planetary science by publishing the proceedings of the Lunar and Planetary Science conferences. I would like to see it play an even larger role by having the Lunar and Planetary Science Conference held less frequently and encouraging more presentations at the meetings of professional societies such as AGU."

Steve C. Solomon A member of AGU since 1967, a Fellow since 1980; 37 years old. Professor of Geophysics, Massachusetts Institute of Technology. Major interests: planetary tectonics, seismology. B.S. in geophysics, California Institute of Technology, 1966; Ph.D. in geophysics, MIT, 1971. On MIT faculty since 1972. Visiting Faculty, UCLA, and Visiting Scientist, Jet Propulsion Laboratory, 1982–83. Member: AAAS, SSA. Has served on the NAS-NRC Space Science Board and its Committee on Planetary and Lunar Exploration, and has chaired its Committee on Earth Sciences. Has also served on the Lunar Sample Analysis Team, VOIR Science Working Group, USRA Lunar and Planetary Science Council, and Lunar and Planetary Review Panel. Currently serves on the Venus Radar Mapper Project Science Group, Geopotential Research Mission Science Steering Group, Crustal Dynamics Working Group, Planetary Geology Working Group, and Joint U.S.-European Working Group for Planetary Exploration. About 80 publications, 30 in AGU journals. NSF Graduate and Postdoctoral Fellow; Hertz Foundation Fellow; Sloan Research Fellow; Guggenheim Fellow. Past Associate Editor, JGR and *Eos*; currently on AGU Geophysical Monograph Board.

Statement

"Planetology within AGU faces several obstacles not shared by the other sections. The field is uniquely diverse; since the earth is obviously a planet, one might even argue that all of the disciplines represented within AGU fall under the planetology heading. Planetologists, defined in the more conventionally limited sense, must also split their loyalties among several organizations, of which AGU is just one. This divided loyalty is particularly severe for meetings; many planetary scientists choose to present their most important results at the DPS meeting or the Lunar and Planetary Science Conference rather than at one of the AGU national meetings.

"What, then, should be the role of AGU in planetary science and of the Planetology Section within AGU? The primary objective of AGU is scientific communication, both among its members and between the Union and the public, including our scientific peers in other fields. AGU, therefore, can serve two roles for planetary science. It is a focus for planetary scientists, probably the broadest-based organization of its kind in the field. And it can foster communication of the discoveries and excitement of planetary science, and indeed all of geophysics, to the rest of the nation. The Planetology Section should play the largest part in the latter task, and has the additional role of keeping the other sections up to date on the most important new results in solar system science.

"The national meetings of AGU are not likely to preempt the DPS meeting or LPSC as the principal meeting at which planetary scientists share new results with each other. The national meetings should rather be used as a forum to organize informative general sessions and to cosponsor with other sections special sessions on topics that span section interests. A recent session dealing with a comparison of the tectonics on Venus and the earth as a guide to the role of plate tectonics in planetary evolution is one good example in the latter category. Joint lunchtime functions with the VGP Section is another. AGU should also act as cosponsor for other meetings in planetary science. The cosponsorship of the Lunar and Planetary Science Conference and the publication of the Proceedings as a supplement to JGR is a laudable, large step in this direction; but AGU involvement could be extended to smaller topical meetings as well.

"AGU's publications in planetary science (JGR, RGSP, GRL) are very strong and should stay that way. In *Eos*, most news of interest to the planetary science community is communicated rapidly and effectively, largely through the efforts of Peter Bell and the *Eos* news staff. Greater use of *Eos* could be made by the Planetology Section, however, for meeting announcements and post-meeting reports. An effective approach taken by the Ocean Sciences and VGP sections is to appoint an Editor to organize and publish section reports in *Eos* on a regular basis.

"The next 5 years will see a restoration of exciting new discoveries in planetary science. In 1986 Voyager will fly by the Uranus system, and Comet Halley will be visited by ESA, Soviet, and Japanese spacecraft; in 1988 Galileo will enter Jupiter orbit, and VRM will begin providing high-resolution radar images of the Venus surface. It will be a time when the Planetology Section should continue to play its vigorous role within AGU."

Planetology: Secretary

Raymond E. Arvidson A member of AGU since 1972; 35 years old; Associate Professor, Department of Earth and Planetary Sciences, and Fellow, McDonnell Center for the Space Sciences, Washington University. Major interests: planetary surfaces, remote sensing, data management. B.A. in Earth Sciences, Temple University, 1969, Ph.D. in Geological Sciences, Brown University, 1974. Faculty member at Washington University since 1974. Former Chairman, Extraterrestrial Sciences Committee, American Society of Photogrammetry. Chairman, Committee on Data Management and Computation, and member of Space Science Board, National Academy of Sciences. Member of several NASA advisory groups. 54 publications, 14 published by AGU. Associate Editor of *Journal Geophysical Research*.

H. J. Melosh A member of AGU since 1975; 35 years old; Associate Professor of Planetary Science at the Lunar and Planetary Laboratory, University of Arizona. Major interests: the mechanics of impact cratering, planetary tectonics, and the application of physical principles to geologic processes. A.B. in physics from Princeton University in 1969; Ph.D. in theoretical physics from Caltech in 1973. Postdoctoral Fellow at the Enrico Fermi Institute of the University of Chicago, 1973–74; Instructor, Assistant Professor, and Associate Professor at Caltech 1974–79; Associate Professor at SUNY, Stony Brook until 1982. Member: Sigma Xi. Served on LPRP (NASA) and is presently on COMPLEX (NAS-NRC); 44 publications, 13 published by AGU.

Lecturers for AGU Science and Policy Seminars Sought

AGU is establishing a series of Science and Policy Seminars. AGU members who have worked with public policy issues involving geophysics are invited to share with university students and faculty their experiences, insights, and expertise. For guidelines on this new and exciting program and application information, write or call:

AGU Member Programs
2000 Florida Avenue, N.W.
Washington, D.C. 20009
(202) 462-6903

Meetings

Announcements

Geology Meeting

The Association of Engineering Geologists will hold its 26th Annual Meeting in San Diego, Calif., October 3–8, 1983. The program will include technical sessions on hazardous waste and hydrogeology, seismicity and faulting stability, landslides and slope stability, and construction and engineering geology. Symposia on engineering geology; mapping symbols; resources exploration, development, and reclamation; rock logging; hydrogeology; engineering geophysics; and the Coalinga earthquake are also on the schedule.

Several field trips will be offered, including one featuring the geology of urban San Diego, and short courses on the applications of soil stratigraphic techniques for engineering geologists and on landslide hazards and their reduction will be available.

For more information contact Doug Shug, Chairman, Registration Committee, c/o Woodward-Clyde Consultants, 3-167 Kurtz St., San Diego, CA 92110 (telephone: 619-224-2911) or John Foster, Chairman, Exhibitors' Committee, c/o Wahler Associates, 2007 Quail St., Newport Beach, CA 92660 (telephone: 714-540-5905).

Planetary Plasmas

A conference sponsored by NASA entitled The Planetary Plasma Environment: A Comparative View will be held January 28 to February 3, 1984, in Yosemite, Calif. The preliminary program includes sections on the comparison of plasma sources and energization processes that exist in the inner and outer planets as well as in comets; internal sources of plasma and ionospheric-magnetospheric coupling in planetary systems; ionospheric processes that serve as the source of ions and the plasma processes by which these plasmas are energized; external sources of plasma and energy from both the solar wind and planetary satellites; and the effects of these plasma and energy sources on the composition and dynamics of the planetary magnetospheres. Because of the breadth and complexity of the conference topics, sections will focus on a few carefully selected examples of the processes under discussion.

A large number of invited papers are already on the agenda. The number of conference attendees will be limited to 100.

For more information contact the coconveners of the conference, J. H. Waite of the NASA/Marshall Space Flight Center (telephone: 205-453-3087 or 3040) or C. R. Chappell of Stanford University (telephone: 415-497-4691). P. M. Banks, C. R. Chappell, and A. F. Nagy are the cochairmen.

Remote Sensing

An international symposium on advancements in remote sensing of land by satellite will be held in Sioux Falls, S. D., October 4–7, 1983. Topics of discussion will include remote sensing developments by the leading countries in the field, the proposed sale of U.S. remote sensing satellite operations to the private sector, U.S. policy on government research and development for future sensor systems, space shuttle remote sensing projects, and developments in research on alternative approaches and on support systems. The symposium, the eighth in a series, honors the memory of William T. Pecora, a pioneer in the field.

"The proceeding's highlights include detailed presentations on Landsat 4 data characteristics and on the technology and the data distribution plans for the French satellite Le Système Probatoire d'Observation de la Terre (SPOT). Landsat 4 is a new generation remote-sensing satellite launched last July and operated by the National Environmental Satellite, Data, and Information Sevice of the National Oceanic and Atmospheric Administration (NOAA).

For more information write PECORA VII, P. O. Box 80937, Sioux Falls, SD 57116, or call the Public Affairs and Technical Information Office at the Earth Resources Observations Systems Data Center (telephone: 605-594-6114). The U.S. Geological Survey, the National Aeronautics and Space Administration, and NOAA are cosponsoring the symposium.

Marine Environment

The 18th Annual Congress of the Canadian Meteorological and Oceanographic Society (CMOS) and the 11th Annual Meeting of the Canadian Geophysical Union (CGU) will be held jointly in Halifax, Nova Scotia, May 29 to June 1, 1984. With a theme of The Marine Environment: Atmosphere, Ocean, and Lithosphere, joint sessions will deal with such topics as geophysical dynamics: atmosphere, ocean, and lithosphere; Arctic expeditions: CESAR, LOREX, and FRAM; scientific services to the offshore industry; climate change; coastal meteorology; oceanography and geophysics; and boundary processes.

Abstracts, not to exceed 400 words, for papers on any topic in meteorology, oceanography, or geophysics will be accepted until January 27, 1984. Send submissions to S. D. Smith (CMOS) or H. R. Jackson (CGU), Bedford Institute of Oceanography, P.O. Box 1006, Dartmouth, Nova Scotia B2Y 4A2, Canada.

Exhibits in the fields of oceanography, meteorology, and geophysics will be on display. For more information about the exhibits contact John Brooke, 24 Flamingo Drive, Halifax, Nova Scotia B3M 1S7, Canada (telephone: 902-443-2952).

AAAS Meeting

The 65th Annual Meeting of the American Association for the Advancement of Science (AAAS), Pacific Division, will be held June 10–15, 1984, in San Francisco, Calif. During the meeting the American Meteorological Society and Section W (Atmospheric and Hydrospheric Sciences) of the Pacific Division of the AAAS will cosponsor sessions.

Abstracts for papers to be presented at the conference must be submitted by March 31, 1984, to the program chairman, John Lier, Department of Geography, California State University, Hayward, CA 94542 (telephone: 415-881-3193). The abstracts should be typed on a standard-sized sheet of bond paper and the camera-ready title and text (without paragraphs) and should fit inside a 5-inch-square (12.5-cm-square) box. A 1-inch (2.5-cm) margin should be maintained to the left of the box. Special symbols and signs that are hand-lettered should be rendered in reproducible black ink. Include the author's name, affiliation, and address at the bottom of the page. These abstracts will be published in a booklet for distribution to conference registrants.

For additional information about the conference contact Alan E. Levitan, Executive Director, AAAS (Pacific Division), California Academy of Sciences, Golden State Park, San Francisco, CA 94118 (telephone: 415-752-1554).

Nonmembers of AAAS are encouraged to attend.

Rural Water

The Program Committee of the International Water Resources Association (IWRA) is soliciting papers for the Fifth IWRA World Congress to be held June 9–15, 1985, in Brussels, Belgium. In order to reflect the meeting's theme of Water Resources for Rural Areas and Their Communities, the papers should deal with such topics as the social and cultural aspects of water usage, education in and transfer of water technology, management and financing of water facilities, equipment and material, assessment and monitoring of water resources, water treatment, alternative energy sources, legal and public health aspects, management of integrated water projects, and management of water resources in disaster areas. Case studies of private practitioners are welcome. The official languages of the conference are English, Spanish, and French.

Authors interested in presenting papers at this conference should submit five copies of one-page abstracts, not to exceed 50 lines, to Fifth World Congress On Water Resources, Brussels International Conference Centre, Parc des Expositions, Tenoonstellingspark, B-1020 Brussels, Belgium (telephone: 32-2-478-48-60; telex: 25-643). The deadline for submissions is September 30, 1983.

Geophysical Year

Boldface meeting titles indicate meetings sponsored or cosponsored by AGU. A list of organization abbreviations used in the list appears below.

Future AGU Meetings:

Fall Meetings
Dec. 5–10, 1983, San Francisco

Spring Meetings
May 14–18, 1984, Cincinnati
May 27–31, 1985, Baltimore

Abbreviations

AAAS American Association for the Advancement of Science
AAPG American Association of Petroleum Geologists
ACS American Chemical Society
AIPG American Institute of Professional Geologists
AMS American Meteorological Society
ASCE American Society of Civil Engineers
AWRA American Water Resources Association
GSA Geological Society of America
IAG International Association of Geodesy
IAGA International Association of Geomagnetism and Aeronomy
IAHS International Association for Hydrological Sciences
IAMAP International Association of Meteorology and Atmospheric Physics
IAPSO International Association of Physical Sciences of the Ocean
IASPEI International Association of Seismology and Physics of the Earth's Interior
IAVCEI International Association of Volcanology and Chemistry of the Earth's Interior
ICSU International Council of Scientific Unions
IUGG International Union of Geodesy and Geophysics
IUGS International Union of Geological Sciences
IWRA International Water Resources Association
MSA Mineralogical Society of America
SEG Society of Exploration Geophysicists
SEPM Society of Economic Paleontologists and Mineralogists
URSI International Union of Radio Science
WMO World Meteorological Organization

1983

Sept. 5–9 48th Annual Meteoritical Society Meeting, Mainz, Germany. (Friedrich Begenstein, MPI für Chemie, Postfach 3060, D-6500 Mainz FRG.)

Sept. 5–9 20th International Congress of the International Association of Hydraulic Research (IAHR), Moscow, USSR (Organizing Committee of the 20th IAHR Congress, Institute "Hydroproject," Volokolamskoe Chaussee 2, Moscow A-80, 125812, USSR.)

Sept. 5–9 Fenrose Conference on Bluetschists and Related Rocks, Bellingham and Seattle, Wash. Sponsor, GSA. (E. H. Brown, Dept. of Geology, Western Washington Univ., Bellingham, WA 98225, or B. W. Evans, Dept. of Geological Sciences A1-20, Univ. of Washington, Seattle, WA 98195.)

Sept. 7–10 AIPG Annual Meeting, Jackson Hole, Wyo. (Gene R. George, General Chairman, P.O. Box 2775, Casper, WY 82602; tel.: 307-265-9190.)

Sept. 11–14 Distribution System Symposium, Birmingham, Ala. Sponsor, American Water Works Association. (AWWA, 6666 West Quincy Ave., Denver, CO 80235; tel.: 303-794-7711.)

Sept. 12–14 National Water Well Association 35th Annual Convention and Exposition, St. Louis.

Meetings (cont. on p. 530)

Meetings (cont. from p. 529)

Mo. (NWWA, 500 West Wilson Bridge Rd., Worthington, OH 43085.)

Sept. 12–16 International Water Supply Association Exhibition and Conferences, Brussels, Belgium. (IWSA Secretariat, 1 Queen Anne's Gate, London SW1 9BT, United Kingdom.)

Sept. 12–16 International Symposium on Isotope Hydrology in Water Resources Development. (IAEA, P.O. Box 100, Vienna International Centre, A-1400, Vienna, Austria.)

Sept. 13–14 12th Annual Conference of the Illinois Department of Energy and Natural Resources on Illinois Climate: Trends, Impacts, and Issues, Urbana, Ill. (M. Maxwell, Office of Conferences and Institutes, Univ. of Illinois, Urbana, IL 61801; tel.: 217-333-2883.)

Sept. 18–21 Eastern Section Annual Meeting, Mohonk Mountain House, N.Y. Sponsor, Seismological Society of America. (Ellyn Schlesinger-Miller or Noel Barstow, Lamont-Doherty Geological Observatory, Palisades, NY 10964; tel.: 914-359-2900.)

Sept. 18–22 Brecciation and Mineralization Invitational Conference, Colorado Springs, Colo. (Leanne Stone, Division of Continuing Education, Univ. of Nevada-Reno, Reno, NV 89557; tel.: 702-784-4046.)

Sept. 19–20 14th Biennial Conference Conference on Ground Water. Sponsors, University of California Water Resources Center and California Department of Water Resources. (The Water Resources Center, University of California, Davis, CA 95616; tel.: 916-752-1544.)

Sept. 19–23 International Technical Conference on National Weather Service Real-Time Data Collection and Natural Flood Hazards, Sacramento, Calif. Sponsors, WMO, NOAA, Calif. Dept. of Water Resources. (R. J. C. Burnash, Calif. Nevada River Forecast Center, National Weather Service, Room 1641, 1416 Ninth Street, Sacramento, CA 95814 or the Secretary-General, WMO, Case Postale No. 5, CH-1211 Geneva 20, Switzerland.)

Sept. 19–25 International Symposium on the Geology of the Taurus Belt, Ankara, Turkey. Sponsor, Mineral Research and Exploration Institute of Turkey and Geological Society of Turkey. (Maden Tetkik ve Arama Enstitüsü (MTA), Toros Jeolojisi Uluslararası Simpozyumu, Dizenleme Kurulu, Ankara, Turkey.)

Sept. 21–23 Technical Symposium on Acid Rain Transport and Transformation Phenomenon, Burlington, Vt. (E. A. Cassell, School of Natural Resources, 335 Aiken Center, Univ. of Vermont, Burlington, VT 05405.)

Sept. 23–24 Models in Geomorphology, Buffalo, N.Y. (Michael Woldenberg, Dept. of Geography, State Univ. of New York, Buffalo, NY 14260.)

Sept. 26–30 Second International Meeting on Statistical Climatology, Lisbon, Portugal. Sponsors, National Science Foundation, Office of Naval Research, WMO. (A. H. Murphy, Dept. of Atmospheric Sciences, Oregon State Univ., Corvallis, OR 97331.)

Sept. 30–Oct. 1 AGU Pacific Northwest Regional Meeting, Bellingham, Wash. (David E. Engebretson, PNAGU, Dept. of Geology, Western Washington State College, Bellingham, WA 98225.)

October Second Iraqi Hydrological Conference, Sponsor, IAHS. (Dr. N. Al Anvari, Ministry of Irrigation, Baghdad, Iraq.)

Oct.–Nov. 22nd Session of the UNESCO General Conference. (Sorin Dumitrescu, Director, Division of Water Sciences, UNESCO, 7, place de Fontenoy, 75700 Paris, France; tel.: 331-577-1610 x6093.)

Oct. 2–7 Penrose Conference on Cretaceous Climates, Colorado Springs, Colo. Sponsors, GSA and the International Geologic Correlation Program. (Eric Barron, National Center for Atmospheric Research, P.O. Box 3000, Boulder, CO 80307.)

Oct. 3–7 Chapman Conference on Magnetic Reconnection, Los Alamos National Laboratory, Los Alamos, N.M. (Meetings, AGU, 2000 Florida Ave., N.W., Washington, DC 20009.)

Oct. 9–12 Meeting: Association of Earth Science Editors, Houston, Tex. (Pamela Jones, Lunar and Planetary Institute, 3303 NASA Road One, Houston, TX 77058; tel.: 713-486-2150.)

Oct. 9–13 19th Annual AWRA Conference and Symposium, San Antonio, Tex. (Kenneth D. Reid, Executive Director, AWRA, 5410 Grosvenor Lane, Suite 220, Bethesda, MD 20814.)

Oct. 9–15 Sixth International Symposium on Environmental Biogeochemistry, Santa Fe, N.M. (James A. Brierley, Department of Biology, New Mexico Institute of Mining and Technology, Socorro, NM 87801.)

Oct. 11–16 Second International Symposium on River Sedimentation, Nanjing, China. (D. Gyoren, Nanjing Hydraulic Research Institute, 223 Guangzhou Road, Nanjing 210024, Peoples Republic of China.)

Oct. 13–14 The Water Resources of Georgia and Adjacent Areas, Atlanta, Ga. Sponsors, Georgia Geologic Survey, Georgia Institute of Technology. (Bernd Kahn, Environmental Resources Center, Georgia Institute of Technology, Atlanta, GA 30332; tel.: 404-894-3776; or Ram Arora, Georgia Geologic Survey, 19 M. L. King Jr., Dr., S.W., Atlanta, GA 30334; tel.: 404-656-3214.)

Oct. 16–20 Fifth International Conference on Basement Tectonics, Cairo, Egypt. Sponsor, Denver-based Basement Tectonics Committee, Inc. (J. J. Gallagher, Jr., Cities Services Co., Box 3908, Tulsa, OK 74102, or S. Riad, Dept. of Geology, Univ. of Assiut, Assiut, Egypt.)

Oct. 17–20 15th Meeting of the Division of Planetary Sciences, American Astronomical Society, Ithaca, N.Y. (Steven J. Ostro, Space Sciences Building, Cornell Univ., Ithaca, NY 14853.)

Oct. 17–21 Technical Conference on Observation and Measurement of Atmospheric Contaminants, Vienna, Austria. Sponsors, WMO, International Atomic Energy Agency, UNEP, and the Austrian Zentralanstalt für Meteorologie und Geophysik. (WMO Secretariat, Attention: C/ENV, Case postale no. 5, CH-1211 Geneva 20, Switzerland.)

Oct. 18–20 Fifth Conference on Hydrometeorology, Tulsa, Okla. (W.I. Pugsley, Program Co-Chairman, Chief Hydrometeorology Division, Canadian Climate Centre, 4905 Dufferin St., Downsview, Ont. M3H 5T4 Canada; tel.: 426-667-4617.)

Oct. 18–20 International Lake and Reservoir Management Symposium, Knoxville, Tenn. Sponsor, North American Lake Management Society. (To send abstracts, Lowell Klessig, College of Natural Resources, Univ. of Wisconsin, Steven's Point, WI 54481; tel.: 715-346-3783. For additional information, Wayne Poppe, TVA, 248 401 Building, Chattanooga, TN 37401; tel.: 615-751-7333.)

Oct. 18–20 Tri-Services Infrared Backgrounds Symposium, Burlington, Mass. Sponsor, Department of Defense. (R.E. Murphy, AFGL/OPR, Hanscom AFB, MA 01731.)

Oct. 22–26 Seventh International Estuarine Research Conference, Virginia Beach, Va. Sponsor, Estuarine Research Federation. (John Kreauter, ERF Treasurer, Crane Aquaculture Facility, BG&E, P.O. Box 1475, Baltimore, MD 21203.)

Oct. 23–28 Symposium on Neotectonics, Seismicity, and Geologic Hazard in the Caribbean and Venezuela, Caracas, Venezuela. Sponsor, INQUA Neotectonics Commission. (André M. Singer P., Depto. Ciencias de la Tierra, FUNVISIS, Apartado Postal 1892, Caracas 101, Venezuela; telex: 26453.)

Oct. 26–28 29th Annual Midwest Groundwater Conference, Champaign, Ill. Sponsor, Illinois State Water Survey. (Ellis W. Sanderson, Illinois State Water Survey, 605 E. Springfield Avenue, P.O Box 5050, Station A, Champaign, IL 61820–9050; tel.: 217-333-0235, or Philip C. Reed, Illinois State Geological Survey, 615 E. Peabody Drive, Champaign, IL 61820; tel.: 217-344-1481.)

Oct. 31–Nov. 2 Shuttle Environment and Operations, Washington D.C. Sponsor, American Institute of Aeronautics and Astronautics. (AIAA, Meeting Dept., 1290 Avenue of the Americas, New York, NY 10019.)

Oct. 31–Nov. 2 Sixth Oak Ridge National Laboratory Life Sciences Symposium, Knoxville, Tenn. Sponsors, U.S. Dept. of Energy, the National Science Foundation, the National Oceanic and Atmospheric Administration, the Electric Power Research Institute, and Gas Research Institute. (Debbie Shepherd, Oak Ridge National Laboratory, P.O. Box X, Building 1505, Oak Ridge, TN 37830, tel.: 615-574-7302).

Oct. 31–Nov. 3 GSA Annual Meeting, Indianapolis, Ind. (J. M. Latulippe, Meetings Dept., GSA, P.O. Box 9140, Boulder, CO 80301.)

Oct. 31–Nov. 4 American Institute of Chemical Engineers, Washington, D.C. (R. Peters, Civil Engineering, Purdue Univ., West Lafayette, IN 47907.)

Nov. 7–8 14th Underwater Mining Institute Meeting, Madison, Wis. (J. R. Monre, Marine Science Institute, Univ. of Texas–Austin, 200 East 26½ St., Austin, TX 78705; tel.: 512-471-4816.)

Nov. 14–17 Seventh International Symposium on the Scientific Basis for Nuclear Waste Management, Boston, Mass. Sponsor, Materials Research Society. (Gary L. McVay, Materials Dept., Battelle Northwest Laboratories, P.O. Box 999, Richland, WA 99352; tel.: 509-375-3762.)

Nov. 16–18 Eighth Conference on Probability and Statistics in Atmospheric Sciences, Hot Springs, Ark. Sponsor, AMS. (R. W. Katz, Dept. of Atmospheric Sciences, Oregon State Univ., Corvallis, OR 97331.)

Nov. 16–18 Third Applied Climatology Conference, Hot Springs, Ark. Sponsors, Committee on Probability and Statistics and Applied Climate Committee of AMS. (Send all abstracts to Wayne M. Wendland, Illinois State Water Survey, P.O. Box 5050, Station A, Champaign, IL 61820.)

Dec. 5–9 International Conference: Goundwater and Man, Sydney, Australia. (The Services Pty Ltd., P.O. Box 1929, Canberra City, ACT 2601, Australia; tel.: 062–49–8015; telex: AA62260 (UNIHS-ACTS).)

Dec. 5–9 Second South East Asian Survey Congress, Hong Kong. Sponsor, Hong Kong Branch of the Royal Institution of Chartered Surveyors and Hong Kong Institute of Land Surveyors. (Congress Secretariat, Second South East Asian Survey Congress, 57 Wyndham Street, 1st Floor, Central, Hong Kong.)

Dec. 5–10 AGU Fall Meeting, San Francisco, Calif. (Meetings, AGU, 2000 Florida Ave., N.W., Washington, DC 20009.)

Dec. 5–16 Workshop on Pattern Recognition and Analysis of Seismicity, Trieste, Italy. (International Center for Theoretical Physics, P.O. Box 586, I-34100 Trieste, Italy.)

Dec. 12–13 Conference on Advances in Infiltration, Chicago, Ill. Sponsors, American Society of Agricultural Engineers, AGU. (J. L. Nieber, Program Chairman, Dept. of Agricultural Engineering, Texas A&M Univ., College Station, TX 77843.)

Dec. 15–17 Second Annual Meeting of the Working Group on Mediterranean Ophiolites, Florence, Italy. (Giovanni B. Piccardo, Instituto di Mineralogia, Petrographia e Geochimica-Università, via La Pira 4, 50121 Firenze, Italy.)

1984

Jan. 9–13 Chapman Conference on Natural Variations in Carbon Dioxide and the Carbon Cycle, Tarpon Springs, Fla. (Meetings, AGU, 2000 Florida Ave., N.W., Washington, DC 20009.)

Jan. 11–14 National Meeting of the International Union of Radio Science (URSI), Boulder, Colo. Sponsor, U.S. National Committee of URSI. (T. E. Van Zandt, NOAA/ERL, R/E/AL3, 325 Broadway, Boulder, CO 80303; tel.: 303-497-3854.)

Jan. 16–20 Microwave Signatures in Remote Sensing, URSI, Toulouse, France. Sponsors, Centre National d'Étude Spatiales, with the participation of URSI Commission F and the Centre d'Étude Spatiale des Rayonnements (CESR). (Technical program, Erwin Schanda, Universität Berne, Institute of Applied Physics, Sidlestrasse 5, 3012 Berne, Switzerland or Richard K. Moore, Remote Sensing Laboratory, Univ. of Kansas Center for Research, Inc., 2291 Irving Hill Drive-Campus West, Lawrence, KS 66045. Registration, F. Cambou, Head, CESR, 9 Avenue du Colonel Roche, B.P. 4346, 31029 Toulouse-Cedex, France.)

Jan. 16–21 Penrose Conference on the Evolution of the Central Atlantic Ocean and its Continental Margins, Glens, France. (J. Sougy, Laboratoire de Géologie Dynamique, LA CNRS no. 132, Faculté des Sciences de Saint Jérôme, 13397, Marseille Cedex 13, France; tel.: (91) 98 90 10, ext. 510.)

Jan. 23–27 Ocean Sciences Meeting, New Orleans, La. (John R. Apel, Assistant Director for Planning, Johns Hopkins Univ., Applied Physics Laboratory, Johns Hopkins Rd., Laurel, MD 20707.)

Jan. 28–Feb. 3 Conference on Planetary Plasma Environment, Yosemite, Calif. Sponsor, NASA. (J. H. Waite, NASA/Marshall Space Flight Center, tel.: 205-453-3037; or C. R. Clauer, Stanford Univ., tel.: 415-497-4691.)

Feb. 7–8 Subsurface Investigations Conference, Surface and Borehole Geophysics, San Antonio, Tex. Sponsor, National Water Well Association. (NWWA, 500 W. Wilson Bridge Rd., Worthington, OH 43085; tel.: 614-846-9355.)

Feb. 9–14 International Symposium on Recent Crustal Movements of the Pacific Region, Wellington, New Zealand. Sponsor, Royal Society of New Zealand. (Secretary, H. M. Bibby, Geophysics Division, DSIR, P.O. Box 1320, Wellington, New Zealand.)

Feb. 20–24 Chapman Conference on Collisionless Shock Waves in the Heliosphere, Napa, Calif. (Meetings, AGU, 2000 Florida Ave., N.W., Washington, DC 20009.)

Feb. 21–24 South East Asia Petroleum Exploration Society (SEAPEX) Meeting with Fifth Offshore Southeast Asia Conference and Exhibition (OSEA), Singapore. (J. MacDonald, OSEA, 6-E Mt. Sophia, Singapore 0922; tel.: 337-3476; telex: RS 20107 TRSHOW.)

Feb. 23–24 15th Meeting, International Erosion Control Association, Denver, Colo. (International Erosion Control Association, Inc., P.O. Box 807, Freedom, CA 95019; tel.: 408-688-3228.)

March 11–16 American Congress on Surveying and Mapping National Meeting, Washington, D.C. (Willard A. Kuncis, 4415 Jensen Pl., Fairfax, VA 22032; tel.: 202-425-8790).

March 14–17 1984 Meeting, Geological Society of America Hydrogeology Division, Northeast Section, Providence, R. I. (Jeff Sgambat, Geraghty and Miller, Inc., 844 West Street, Annapolis, MD 21401; tel.: 301-268-7730.)

March 19–23 Fifth Northern Research Basins Symposium and Workshop, Vierumaki, Finland. (Olli Faasanen, Secretary, Organizing Committee, Hydrological Office, Box 436, 00101 Helsinki 10, Finland.)

March 19–24 Third International Symposium on Land Subsidence, Venice, Italy. Sponsor, IAHS. (A. I. Johnson, Program Chairman, Third International Symposium on Land Subsidence, Woodward-Clyde Consultants, 7600 East Orchard Rd., Englewood, CO 80111.)

March 19–27 Sixth Session of the International Hydrological Program

March 22–29 Seventh International Symposium on Equatorial Aeronomy (ISEA), Hong Kong. Sponsors, ICSU Committee on Space Research, IUGG, IAGA, IAMAP, and URSI. (S. Matsushita, Chairman, ISEA, High Altitude Observatory, NCAR, P.O. Box 3000, Boulder, CO 80307; tel.: 303-494-5151.)

March 26–27 South-Central Section Meeting of the GSA, Dallas, TX. (Jean Latulippe, Meetings Dept., GSA, Boulder, CO 80301; tel.: 303-447-2020).

March 28–30 International Symposium on Earthquake Relief in Less Industrialized Areas, Zurich, Switzerland. (Swiss National Committee for Earthquake Engineering, SIA Postfach, CH-8039, Zurich, Switzerland.)

April Arctic Water Pollution Research: Applications of Science and Technology, Yellowknife, N.W.T., Canada. (W.A. Bridgeo, Bridco Values, Ltd., P.O. Box 3161, Halifax South Post Office, Nova Scotia B3J 3H5, Canada.)

April CSCE/ASCE Cold Regions Engineering Specialty Conference on Northern Resource Development, Edmonton, Alberta. (Daniel W. Smith, Dept. of Civil Engineering, University of Alberta, Edmonton, Alberta T6G 2G7, Canada.)

April International Conference on Recent Advances in Mineral Science and Technology, Johannesburg, South Africa. Sponsor, South African Council for Mineral Technology (Mintek). (The Conference Secretary (C.25), Mintek, Private Bag X3015, Randburg, 2125 South Africa.)

April 3–5 Interdisciplinary Conference on Meeting the Water Needs of the Southwest, Dallas, Tex. (Michael A. Collins, School of Engineering and Applied Science, Southern Methodist University, Dallas, TX 75275; tel.: 214-692-3060.)

April 4–6 Joint North-Central Section and South-east Sections Meeting of the GSA, Lexington, Ky. (Jean Latulippe, Meetings Dept., GSA, Boulder, CO 80301; tel.: 303-447-2020).

April 24–27 Pacific Conference on Marine Technology (PACON 84), Honolulu, Hawaii. Sponsor, Marine Technology Society. (PACON 84, Center for Engineering Research, Univ. of Hawaii at Manoa, Honolulu, HI 96822, tel.: 808-948-7338 or 7449.)

April 30–May 3 30th Annual Technical Meeting: Environmental Integration Technology Today for a Quality Tomorrow, Orlando, Fla. Sponsor, Institute of Environmental Sciences. (Institute for Environmental Sciences, 940 E. Northwest Hwy., Mount Prospect, IL 60056; tel.: 312-255-1561.)

May-June 12th International Congress on Irrigation and Drainage, Fort Collins, Colo. (ICID, 48 Nyaya Marg, Chanakyapuri, New Delhi 110012, India.)

May 7–9 Third Symposium on Arctic Air Chemistry, Downsview, Ont., Canada. (L. A. Barrie, Atmospheric Environment Service, 4905 Dufferin St., Downsview, Ontario M3H 5T4, Canada, tel.: 416-667-4785; or K. A. Rahn, Graduate School of Oceanography, Univ. of Rhode Island, Narragansett, RI 02882–1197, tel.: 401-792-6234.)

May 14–18 AGU Spring Meeting, Cincinnati, Ohio. (Meetings, AGU, 2000 Florida Ave., N.W., Washington, DC 20009.)

May 20–25 International Symposium on Deep Observation and Sampling of the Continental Crust Through Drilling, Tarrytown, N. Y. (Barry Raleigh, Director, Lamont-Doherty Geological Observatory, Palisades, NY 10964; tel.: 914-359-2900.)

May 21–23 International Groundwater Symposium on Groundwater Resources Utilization and Contaminant Hydrogeology, Montreal, Canada. Sponsors, Canadian National Chapter of the International Association of Hydrogeologists, and the Canadian Water Well Association. (A. Kohut, Chairman, International Groundwater Symposium Montreal '84, Ministry of the Environment, 765 Broughton St., Victoria, British Columbia, V8V 1X5, Canada).

May 21–23 Symposium on Climate: History, Periodicity, and Predictability, New York, N. Y. (John E. Sanders, Dept. of Geology, Barnard College, Columbia Univ., New York, NY 10017; tel.: 212-280-4312.)

May 23–25 Fourth National Symposium and Exposition on Aquifer Restoration and Ground Water Monitoring, Columbus, Ohio. Sponsor, National Water Well Association. (NWWA, 500 W. Wilson Bridge Rd., Worthington, OH 43085; tel.: 614-846-9355.)

May 24–26 Symposium on the History of Soil and Water Conservation, Columbia, Mo. Sponsors, Missouri Cultural Heritage Center at the Univ. of Missouri, the Agricultural History Society, and the Soil Conservation Service of the U.S. Dept. of Agriculture. (Susan Flader, Dept. of History, Univ. of Missouri, Columbia, MO 65211, tel.: 314-882-2481 or 314-442-1058; or Douglas Helms, Historian, Soil Conservation Service, P.O. Box 2890, Washington, DC 20013, tel.: 202-382-0042).

May 28–June 2 12th International Congress on Irrigation and Drainage, Fort Collins, Colo. Sponsor, U.S. Committee on Irrigation, Drainage, and Flood Control. (U.S. Committee on Irrigation, Drainage, and Flood Control, P.O. Box 15326, Denver, CO 80215.)

May 29–June 1 Joint Meeting of the 11th Annual Meeting of the Canadian Geophysical Union and the 18th Annual Congress of the Canadian Meteorological and Oceanographic Society, Halifax, Nova Scotia, Canada. (S. D. Smith or H. R. Jackson, Bedford Institute of Oceanography, P.O. Box 1006, Dartmouth, Nova Scotia, Canada B2Y 4A2.)

Summer Summer Computer Simulation Conference, Boston, Mass. Sponsor, Society for Computer Simulation. (SCS, P.O. Box 2228, La Jolla, CA 92038.)

June 4–8 Seventh International Conference on Atmospheric Electricity, Albany, N. Y. Sponsors, International Commission on Atmospheric Electricity (of IAMAP) and AMS. (R. E. Orville, Atmospheric Electricity Conference, E.S. 214, 1400 Washington Ave., SUNYA, Albany, NY 12222; tel.: 518-457-3987.)

June 10–15 65th Annual AAAS Meeting (Pacific Division), San Francisco, Calif. (Alan E. Leviton, Executive Director, AAAS (Pacific Division), California Academy of Sciences, Golden State Park, San Francisco, CA 94118, tel.: 415-752-1554.)

June 11–13 Symposium on Critical Assessment of Forecasting in Western Water Resource Management, Seattle, Wash. Sponsor, American Water Resources Association. (Gary R. Minton, President, Resource Planning Associates, 113 Lynn Street, Seattle, WA 98109; tel.: 206-282-1681.)

June 23–30 Penrose Conference on Melanges of the Appalchian Orogen, Newfoundland. Sponsor, Geological Society of America. (Brenna E. Lorenz, Department of Earth Sciences, Memorial University of Newfoundland, St. John's, Newfoundland A1B 3X5 Canada.)

June 24 International Conference on Geomembranes, Denver, Colo. (A. Ivan Johnson, Woodward-Clyde Consultants, 7600 E. Orchard Road, Englewood, CO 80111; tel.: 303-694-2770.)

June 24 International Symposium on Impermeable Barriers for Soil and Rock, Denver, Colo. (A. Ivan Johnson, Woodward-Clyde Consultants, 7600 E. Orchard Road, Englewood, CO 80111; tel.: 303-694-2770.)

June 25–27 Rock Mechanics in Protection and Productivity, 25th U.S. Symposium on Rock Mechanics, Evanston, Ill. Sponsor, AGU. (Charles H. Dowding, Dept. of Civil Engineering, Northwestern Univ., Evanston, IL 60201; tel.: 312-492-7270.)

June 25–27 Symposium of the Achievements of the International Magnetospheric Study, Graz, Austria. Sponsor, Scientific Committee on Solar-Terrestrial Physics of ICSU. (J. G. Roederer, Geophysical Institute, Univ. of Alaska, Fairbanks, AK 99701.)

June 25–July 7 Symposium on Space Observations for Climate Studies, Graz, Austria. Sponsor, World Climate Program. (S. Ruttenberg, Secretary, COSPAR Commission A, NCAR, Boulder, CO 80307.)

June 26–28 International Symposium on Deep Structure of the Continental Crust: Results from Reflection Seismology, Ithaca, N.Y. Sponsor, AGU. (Muawia Barazangi, Conference Coordinator, Dept. of Geological Sciences, Cornell Univ., Ithaca, NY 14853; tel.: 607-256-6411 or Telex 937-178.)

July 19–25 Symposium on Wave Breaking, Turbulent Mixing, and Radio Probing of the Ocean Surface, Sendai, Japan. (O. M. Phillips, Department of Earth and Planetary Sciences, The Johns Hopkins University, Baltimore, MD 21218; tel.: 301-338-7036.)

July 21–28 Eighth World Conference on Earthquake Engineering, San Francisco, Calif. Sponsor, Earthquake Engineering Research Institute (EERI), AGU. (J. Penzien, Chair-8WCEE, EERI 2620 Telegraph Avenue, Berkeley, CA 94704.)

July 24–26 Water Rights Specialty Conference, Flagstaff, Ariz. Sponsors, Ground Water Committee and Surface Water Committee of the Irrigation and Drainage Division of the ASCE. (Symposium contact, Kenneth G. Renard, Southwest Watershed Research Center, 2000 E. Allen Road, Tucson, AZ 85719; tel.: 602-629-6381.)

July 26–27 A Joint Workshop of the Committee on Climatic Changes and the Ocean and the Joint Scientific Committee for World Climate Research Panel, Sendai, Japan. (O. M. Phillips, Department of Earth and Planetary Sciences, The Johns Hopkins University, Baltimore, MD 21218; tel.: 301-338-7036.)

July 31–Aug. 2 Fourth International Symposium on Stochastic Hydraulics, Univ. of Illinois, Urbana-Champaign. Sponsors, International Association of Hydraulic Research and AGU. (Ben C. Yen, Wilson H. Tang, or Glenn E. Stout, Dept. of Civil Engineering, Univ. of Illinois, 208 N. Romine St., Urbana, IL 61801; tel.: 217-333-0687 or 333-0536.)

July 31–August 3 Workshop on Fission Track Dating, Troy, N.Y. Sponsors, General Electric Research and Development Laboratory, State University of New York at Albany, and Rensselaer Polytechnic Institute. (Donald S. Miller, Department of Geology, Rensselaer Polytechnic Institute, Troy, NY 12181.)

Aug. 4–14 27th International Geological Congress, Moscow, USSR. Sponsors, USSR National Committee for Geology, IUGS. (Organizing Committee of the 27th IGC, Institute of the Lithosphere, 22, Staromonetny, Moscow, 109180, USSR.)

Aug. 12–16 20th Annual AWRA Conference and Symposium, Washington, D.C. (A. Dietz, Corps of Engineers, Institute for Water Resources, Kingman Bldg., Fort Belvoir, VA 22060.)

Aug. 13–16 20th Annual Water Resources Conference, Washington, D. C. Sponsor, AWRA. (Arthur Dietz, U.S. Army Corps of Engineers, Institute for Water Resources, Casey Bldg., Fort Belvoir, VA 22060, tel.: 202-325-6768.)

Aug. 21–29 International Radiation Symposium '84 (IRS), Perugia, Italy. Sponsor, Radiation Commission of IAMAP. (Giorgio Fiocco, Chairman, IRS '84, Dipartimento di Fisica, Città Universitaria, 00185 Rome, Italy; Telex: INFNRO 613255.)

Sept. 3–7 Quadrennial Ozone Symposium, Halkidiki, Greece. Sponsors, International Ozone Commission of IAMAP, Commission of the European Communities, the Academy of Athens, and the WMO. (Christos S. Zerofos, Chairman, Local Organizing Committee, Physics Dept., Campus Box 149, Univ. of Thessaloniki, Thessaloniki, Greece. Send copy of information request to C. D. Walshaw, Secretary, International Ozone Commission, Clarendon Laboratory, Oxford Univ., Parks Road, Oxford, OX1 3PU, UK.)

Sept. 26–28 Seventh National Groundwater Quality Symposium, Las Vegas, Nev. Sponsor, National Water Well Association. (NWWA, 500 W. Wilson Bridge Rd., Worthington, OH 43085; tel.: 614-846-9355.)

Oct. 17–19 AIPG Annual Meeting, Orlando, Fla. (Bobby J. Timmons, General Chairman, Timmons Associates, P.O. Box 50606, Jacksonville, FL 32250; tel.: 904-246-1533.)

Oct. 31–Nov. 7 Regional Assembly of IASPEI, Hyderabad, India. (Mohan L. Gupta, Organizing Committee, IASPEI Regional Assembly, National Geophysical Research Institute, Hyderabad-500 007, India; telex: 155–478 NGRI IN; cable: Geophysics.)

Nov. 5–8 GSA Annual Meeting, Reno, Nev. (Jean Latulippe, GSA, P.O. Box 9140, Boulder, CO 80301; tel.: 303-447-2020).

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January International Congress of the International Association of Hydrogeologists (IAH), Tucson, Ariz. Sponsors, IAH, AGU. (E. S. Simpson, Chairman of the Arrangements Committee, College Dept. of Hydrology and Water Resources, College of Earth Sciences, Univ. of Arizona, Tucson, AZ 85721.)

March 10–15 American Congress on Surveying and Mapping National Meeting, Washington, D.C. (Willard A. Kuncis, 4415 Jensen Pl., Fairfax, VA 22032; tel.: 202-425-8790.)

May 27–31 AGU Spring Meeting, Baltimore, Md. (Meetings, AGU, 2000 Florida Ave., N.W., Washington DC 20009.)

Summer Colloquium on Comparative Study of Magnetospheric Systems, France. (Dominique Le Quéau and Bent Møller-Pedersen, DASOP, Observatoire de Meudon, F 92195, Meudon Principal Cedex, France; Telex: 200 590 CNET OBS.)

June 9–15 IWRA Fifth World Congress, Brussels, Belgium. (Fifth World Congress On Water Resources, Brussels International Conference Centre, Parc des Expositions, Tentoonstellingpark, B-1020 Brussels, Belgium; tel.: 32-2-478-48-60; telex: 23–643.)

Aug. 5–16 IAMAP/IAPSO Joint Assembly, Honolulu, Hawaii. (Meetings, AGU, 2000 Florida Ave., N.W., Washington, DC 20009.)

Aug. 19–23 Sixth Gondwana Symposium, Columbus, Ohio. Sponsor, GSA. (D. Elliot, Ohio State Univ., Institute of Polar Studies, 103 Mendenhall, 125 South Oval Mall, Columbus, OH 43210.)

Sept. 17–21 AIPG Annual Meeting, St. Paul, Minn. (Robert E. Prendergast, General Chairman, Geotechnical Engineering Corp., 1925 Oakcrest Ave., Roseville, MN 55113; tel.: 612-636-7744.)

Oct. 14–17 GSA Annual Meeting, Boston, Mass. (Jean Latulippe, GSA, P.O. Box 9140, Boulder, CO 80301; tel.: 303-447-2020).

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Aeronomy

0430 Composition (atomic or molecular)
AN OBSERVATIONAL STUDY OF WATER VAPOR IN THE MID-LATITUDE MESOSPHERE USING GROUND-BASED MICROWAVE TECHNIQUES
A. K. Bevilacqua (Code 4138BE, Naval Research Laboratory, Washington, D. C. 20375), J. J. Olivero, P. R. Schwartz, C. J. Gibbins, J. M. Bologna, and D. L. Thacker

Ground-based spectral line measurements of the 22.2 GHz water vapor atmospheric emission line are used to deduce the mesospheric water vapor profile. The results generally indicate that the water vapor mixing ratio is independent of height or increasing slowly in the 50 to 65 km range with typical values of between 5 and 8 ppmv. (Thacker et al. [1981] contains an analysis of the 1980 data sets obtained in this experiment, which indicated the existence of a pronounced layer of water vapor near 65 km. The reanalysis of this data contained in this paper, which includes the estimation and removal of spectral baselines, results in marked smoothing of the water vapor mixing ratio profile in the lower mesosphere, and the peak is much less pronounced.) Above 65 km the mixing ratio is seen to decrease rather rapidly to values of near 1 ppmv at 85 km. This decrease is far steeper than that expected from photochemical considerations. There has also been a large amount of variability observed in the water vapor profiles, especially on the day-to-day time scale. The water vapor retrievals have been used to estimate the vertical component of the upper mesospheric eddy diffusion coefficient (K_z). This analysis has indicated either that vertical transport time scales in the mesosphere are perhaps an order of magnitude longer than previous studies have shown, or that present understanding of the factors important in controlling the vertical distribution of water vapor in the mesosphere is inadequate.
J. Geophys. Res., Green, Paper 3C1199

0440 Convection, diffusion, mixing, turbulence, and fal
ESTIMATION OF TURBULENT ENERGY DISSIPATION, WINDS AND I SPECIFIC STRUCTURE FROM DYNASONDE MEASUREMENTS
J. W. Wright (Cooperative Institute for Research in Env Sciences (CIRES), Campus Box 449, University of Colorad Boulder, CO. 80309), R. D. Hunsucker

A sample of Dynasonde observations at Cleary, Alaska daytime E-Region, in Ionogram and Kinesonde observing m shown to satisfy analysis criteria leading to winds and lence. The wind effects on the ionization distribution E-Region are shown to be consistent with the 'wind shea theory' for the Sporadic E phenomenon at this large mag (66.9°). The lifetime of neutral atmospheric density f tions is deduced using standard phase-screen diffractio arguments, and is shown to yield plausible values for t rate of turbulent eddy diffusion. This suggests the va hence systematic and long-term Dynasonde measurement pro dedicated to studies of the turbopause.
Rad. Sci., Paper 3S0862

0430 (Traveling ionospheric disturbances)
THE DISPERSION OF TRAVELING IONOSPHERIC DISTURBANCES
M. C. Morgan (Radiophysics Laboratory, Thayer School of Engineering, Dartmouth College, Hanover, New Hampshire, 03755), R.L. Tedd

The horizontal dispersion of relatively large daytime TID events seen by the Dartmouth rapid-run ionosonde network is found to conform, at least qualitatively, to that predicted by previous theoretical treatments of freely propagating gravity waves in the presence of dissipation. The availability of TID vertical trace speeds, in addition to horizontal speeds, has allowed a direct comparison with gravity wave dispersion relations and dissipative criteria. Good agreement is found with theory for waves measured at the height of maximum gravity wave amplitude, but rather less convincing results are found at greater heights. The latter may be explained in part by the fact that ion diffusion was neglected in the inversion technique employed to derive the vertical component of the phase propagation vector of the gravity wave from that of the TID.
J. Geophys. Res., Blue, Paper 3A1357

0490 Instruments (Ozone Measurement)
INTERCOMPARISON OF NIMBUS 7 SOLAR BACKSCATTERED ULTRAVIOLET (SBUV) OZONE PROFILES WITH ROCKET, BALLOON AND UMKEHR PROFILES
P.K. Bhartia (Systems and Applied Sciences Corp., 6811 Kenilworth Ave., Riverdale, Md. 20737; also at 5809 Annapolis Rd., Hyattsville, Md. 20784), K. F. Klenk, A. J. Fleig, C. G. Wellemeyer and D. Gordon

A global ozone data set covering the two years from November, 1978 until October, 1980, with an average of 1100 profiles per day has been produced and archived from the Solar Backscattered Ultraviolet (SBUV) instrument flown on the Nimbus 7 spacecraft. The SBUV ozone profiles are compared with measurements from chemical and optical sensors launched on balloons and rockets and with ozone profiles obtained from the ground based Dobson spectrophotometers using the Umkehr method. The biases between the SBUV results and the balloon and Umkehr results are generally less than 10%. These biases are functions of layer height and latitude and are believed to be largely due to uncertainties in the ozone absorption cross-sections used for the various measurement systems. The precision of the SBUV measurements is found to be better than 8% for pressures between 1 and 64 mb and better than 15% from 64 to 253 mb. (Vertical distribution of ozone, SBUV experiment, comparison of ozone measuring techniques).
J. Geophys. Res., Green, Paper 3C1227

Exploration Geophysics

0920 Magnetic and electrical methods
A DEEP CRUSTAL ELECTROMAGNETIC SOUNDING IN THE GEORGIA PIEDMONT
R. G. Thompson (School of Applied and Engineering Physics, Cornell University, Ithaca, NY 14853), A. Kaufman and A. F. Yuckes

Electromagnetic soundings in the Georgia Piedmont using a horizontal loop source indicate an upper layer with conductivity variations less than 2×10^{-5} to 2×10^{-4} Siemens/m extending to about 15 km, underlain by a zone with conductivity of more than 10^{-3} S/m. At one site the conductance of any intermediate layer is limited to 2 S to a depth of 15 km. The conductivities of the upper layer agree with those expected from the surface geology and the increase in conductivity occurs at a depth which correlates generally with reflections detected by COCORP's seismic profile of the area. A possible source of the high conductivity is water saturated sediments trapped when the region was overthrust in the Appalachian orogeny. (Electromagnetic sounding, Appalachians).
J. Geophys. Res., Red, Paper 3B1260

0999 General (Wide Angle Reflection)
SEDIMENT SOUND VELOCITIES FROM SONOBUOYS: SUNDA TRENCH AND FOREARC BASINS, NICOBAR AND CENTRAL BENGAL FANS, AND ANDAMAN SEA BASINS
T. Bachman (Naval Ocean Systems Center, San Diego, California, 92152), E. L. Hamilton, and J. R. Curray

Measurements of mean sound velocities in the first, largely unlithified layers in the sea floor were made using the sonobuoy technique in several areas in the northern Indian Ocean. Older measurements were added to new measurements and regressions for mean and instantaneous velocity versus one-way travel time of sound are presented for the Central Bengal Fan, the Central Andaman Sea Basin, the Nicobar Fan, and the Sunda Trench. New data and regression equations are presented for the Mergui-North Sumatra Basin and for four forearc basins between Sumatra and Java and the Sunda Trench. Minimum velocity gradients were found in those areas where sedimentation rates were high, and sediments have accumulated in thick sections which have not had time to fully consolidate (porosity in the top of the sediment section has not been fully reduced under overburden pressure). These minimum velocity gradients (just under the sea floor) were found in the four forearc basins where they ranged from $0.34\ s^{-1}$ to $0.84\ s^{-1}$ with an average of $0.58\ s^{-1}$. The near-surface velocity gradient in the Sunda Trench was $1.33\ s^{-1}$, but was higher in the adjacent, fossil Nicobar Fan ($1.62\ s^{-1}$). In the surface of the Bengal Fan the velocity gradient was low in the upper fan ($0.86\ s^{-1}$), high in the central fan ($1.94\ s^{-1}$), and again lower in the southern fan ($1.18\ s^{-1}$), which may support sedimentation models calling for bypassing of the central fan and higher rates of accumulation on the southern fan.
J. Geophys. Res., Red, Paper 3B1252

Geochemistry

1410 Chemistry of the atmosphere
THE ROLE OF THE OCEAN IN THE GLOBAL ATMOSPHERIC SULFUR CYCLE
B.C. NGUYEN (Centre des Faibles Radioactivités, CNRS/CEA, 91190 Gif-sur-Yvette, France), B. Bonsang and A. Gaudry

The background atmospheric SO_2 concentration above the sea surface has been established at 0.1×10^{-6} g/m^3 (35 pptv). Several hypotheses to explain the origin of SO_2 above the ocean far from continental sources have been discussed. We have shown that the most likely hypothesis is the biogenic production of reduced organic sulfur compounds in the ocean. The most obvious example is dimethylsulfide (DMS) with seawater concentration varying between 10 and 60×10^{-9} g/l. DMS subsequently diffuses into the atmosphere, where it has been measured at very low concentrations ranging from 0.5 to 80×10^{-9} g/m^3 (0.2 to 29 pptv). We estimate that a mean lifetime of 11 minutes could be a lower limit for DMS in the marine atmosphere. Biological activity has been shown to influence the production of DMS ; the richer the biological activity (for example in a convergence area), the higher the concentration of DMS. DMS and other reduced compounds such as CH_3SH and CH_3SSCH_3 are emitted into the atmosphere and oxidized here by complex mechanisms which are photochemically induced. That leads to SO_2 formation and subsequently to sulfate. A biological influence has also been determined on atmospheric SO_2 concentrations. The flux of sulfur by this process : biological activity → organic sulfides → SO_2 → $SO_4^=$ is estimated to be $44 \pm 13 \times 10^6$ tons of sulfur per year. This biogenic production is of the same order of magnitude as atmospheric sulfur production by sea spray, which is about 44×10^6 T S/yr. The oceanic production by these two processes could be estimated therefore at about 88×10^6 T S/yr. (Ocean/atmosphere exchange, gas-particle conversion, sulfur budget).
J. Geophys. Res., Green, Paper 3C1233

1410 Chemistry of the atmosphere
SEASONAL, LATITUDINAL, AND SECULAR VARIATIONS IN THE ABUNDANCE AND ISOTOPIC RATIOS OF ATMOSPHERIC CARBON DIOXIDE 1. RESULTS FROM LAND STATIONS
Willem G. Mook, Marjan Koopmans, Alane F. Carter and Charles D. Keeling (Scripps Institution of Oceanography, University of California at San Diego, La Jolla, California 92093)

Between March, 1977 and February, 1982, 517 samples of air were collected in 5 liter glass flasks at four stations in the northern hemisphere near the Pacific ocean and at the South Pole. First the CO_2 concentration of each sample was determined by nondispersive infrared gas analysis, and then the $^{13}C/^{12}C$ and $^{18}O/^{16}O$ ratios of the cryogenic extracted CO_2 were determined with a triple collector mass spectrometer. For each station the secular trend and seasonal variation in $^{13}C/^{12}C$ ratio have been established as a function of CO_2 concentration. The seasonally adjusted $^{13}C/^{12}C$ ratio is found to have decreased at a rate of about .02‰ per ppm increase in the seasonally adjusted CO_2 concentration, and to vary with latitude as expected if CO_2 is being released by fossil fuel combustion in the northern hemisphere and from ocean water near the equator. At the three northernmost stations (La Jolla, California at 33°N and two Hawaiian stations near 19°N) the $^{13}C/^{12}C$ ratio of the CO_2 added to and withdrawn from the atmosphere during one annual cycle is circa −29‰ with respect to standard PDB, as expected from the exchange of atmospheric CO_2 with the carbon of terrestrial plants. Near the equator at Fanning Island (4°N) the similarly computed $^{13}C/^{12}C$ ratio is −21‰, while at the South Pole it is about −13‰. This suggests that the seasonal variation in the southern hemisphere and tropics is partially a result of oceanic CO_2 exchange. (Carbon 13, atmospheric CO_2).
J. Geophys. Res., Green, Paper 3C0971

1460 Geochronology (age determinations by radioactive processes)
$^{10}Be/^{9}Be$ RATIOS IN RECENT AND ANCIENT MOLLUSCS
M. Paul (Racah Institute of Physics, Hebrew University, Jerusalem, Israel), A. Kaufman, M. Magaritz, D. Fink, W. Henning, J. Gerber, W. Kutschera, R. Kaim, M. B. Goldberg, and I. S. Brenner [as printed: M. Paul (Racah Institute of Physics, Hebrew University, Jerusalem, Israel), A. Kaufman, M. Magatits, B. Patera, M. B. Goldberg, R. Kaim, J. Gerber, W. Hering, W. Henning, W. Kutschera and I. S. Brenner]

Marine mollusc shells from various oceans and seas were analysed for their concentration of ^{10}Be by accelerator mass spectrometry (AMS) and of ^{9}Be by inductively coupled plasma atomic emission spectrometry (ICPAES). The ratio $^{10}Be/^{9}Be$ varied appreciably for different shells, indicating strong dependence on local conditions. However, the lowest ratio was measured in a Pliocene shell from Italy, consistent with its age of 2.5 to 3 million years.
J. Geophys. Res., Green, Paper 3C1105

Geodesy and Gravity

1910 Crustal movements
LOCAL GRAVITY ANOMALIES PRODUCED BY DISLOCATION SOURCES
J. C. Savage (U.S. Geological Survey, 345 Middlefield Road, MS/77, Menlo Park, California, 94025)

Rundle [1978] and Walsh and Rice [1979] have shown that the change in the vertical component of gravity is proportional to uplift for a spherical source of dilatation and for slip on an infinitely long dip-slip fault. In the first case no free-air gravity anomaly is produced and in the second case no Bouguer gravity anomaly. Gravity anomalies due to other dislocation sources in three dimensions are as follows: For strike-slip faulting the ratio of the gravity change to uplift depends upon position; however, the gravity change contours are roughly similar to those corresponding to a zero free-air gravity anomaly. Nor is the ratio constant for dip-slip faulting except for the two special cases of dip slip on a vertical fault and horizontal slip on a horizontal fault, neither of which produce a Bouguer anomaly. The Bouguer anomaly produced by an open horizontal crack is the same as would be produced had the material within the crack been mined out without deforming the solid. If the horizontal crack were filled with material of density equal to the host rock (a good approximation to sill formation), no Bouguer anomaly is produced. For cracks of other inclinations the ratio of gravity change to uplift is not constant. Thus, dilatancy, in general, does not correspond to the absence of a free-air anomaly as might be suggested by the special case of a spherical source of dilatation. For two-dimensional models a cylindrical source of dilatation produces no free-air gravity anomaly, dip-slip faulting produces no Bouguer anomaly, and open cracks produce a Bouguer anomaly equal to that which would be produced had the material within the crack been mined out without deforming the solid. A two-dimensional crack filled with material of density equal to that of the host rock would produce no Bouguer anomaly. Jachens et al. (1983) have reported temporal changes in gravity, elevation, and areal strain along the San Andreas fault in southern California such that the Bouguer anomaly apparently remains unchanged and the uplift-to-strain ratio is about −100 km. Several dislocation mechanisms are proposed that fulfill these constraints, but these mechanisms appear to be rather contrived and are not regarded as satisfactory explanations. (Gravity anomalies, dislocation sources).
J. Geophys. Res., Red, Paper 3B1258

1950 (Relations of gravity observations...)
GRAVITY ANOMALIES AND FLEXURE OF THE LITHOSPHERE AT MOUNTAIN RANGES
G. D. Karner (Lamont-Doherty Geological Observatory of Columbia Univ., Palisades, N.Y. 10964) and A.B. Watts

The Bouguer gravity anomaly over the Himalayan, Alpine, and Appalachian mountains is characterized by a generally asymmetric gravity 'low' which spans the mountains and associated foreland basins. The minimum of the gravity 'low' is generally systematically displaced from the region of greatest topographic relief and shows no obvious relationship to surface geology. In addition, the Alps and Appalachians are associated with a generally symmetric gravity "high" that is unrelated to the topographic relief. Together, the gravity low and high form a characteristic positive-negative anomaly "couple". The steep gravity gradient between the positive-negative couple correlates with the Insubric line and its equivalents in the Alps, and the Brevard Zone in the southern Appalachians. This gravity anomaly couple is interpreted as evidence for flexure of the continental lithosphere by sub-surface (buried) and surface (topographic) loading. The magnitude of the sub-surface load is estimated from the integrated excess mass represented by the positive anomaly, and the magnitude of the surface load from the topography. By combining these loads, the flexure of the lithosphere and the associated Bouguer gravity anomaly are calculated for different assumed values of the elastic thickness, T_e, of continental lithosphere. The best fitting value of T_e for the Himalayas is 80-100 km, for the Alps 25-50 km, and for the Appalachians, 80-130 km. The model calculations suggest that the main contribution to the gravity couple in the Alps and Appalachians arises not from surface loads such as thrust sheets and nappes, but from sub-surface loads. However, in the case of the Himalayas, the topography appears to be a sufficient load to explain the observed asymmetric gravity low. When sub-surface loads do exist therefore, we would not expect a close correlation between mountain topographic relief and depth to the M-discontinuity as required by classical models of isostasy. Rather, the M-discontinuity is expected to relate to the center of mass of all the loads acting on the lithosphere. The surface and sub-surface loads, inferred from the gravity anomaly, play a major role in the development of mountains and foreland basins. The emplacement of large sub-surface loads represents the primary event in the Alps and Appalachians, while in the Himalayas, the emplacement of the surface load is the primary event. The emplacement of the sub-surface load probably marks the initiation of foreland basin development. The regional characteristics of the basin are controlled by the primary load, while local variations are controlled by the secondary, thrust sheet loads. Subsequent movement of either load will produce migration of the basin depocenter. The origin of the subsurface load is not clear, but its association with the Insubric line in the Alps, and the Brevard Zone in the Appalachians, suggests it may be related to the "obduction" of crustal blocks/flakes onto the underlying plate during continental collision, or possibly to the preloaded crustal structure of the underlying plate.
J. Geophys. Res., Red, Paper 3B1159

Geomagnetism and Paleomagnetism

2530 Spatial variations full harmonics and anomalies.
VARYING GEOMAGNETIC ANOMALIES AND SECULAR VARIATION
Leroy R. Alldredge (U.S. Geological Survey, Denver, CO 80225)

The time variations of the geomagnetic field at 10 European observatories were examined in detail. Fourier analyses were made for three field components at each of the observatories. Curves for each component were synthesized for three passbands: A low passband for periods greater than 30 years, a mid passband for periods equal to or less than 30 years but greater than 13 years. The low passband results show only very smooth variations from which the linear prediction of secular variation, as is now in use, might give a good average result for 10-15 years if there were no other changes. The high passband results show the solar cycle effect that has been adequately treated before. The mid passband has an amplitude of tens of nT which changes differently at each observatory in such a way as to infer core sources. These time-varying anomalies are important to the understanding of secular variation. (Secular variation, anomalies, time variations)
J. Geophys. Res., Red, Paper 3B1063

2560 Paleomagnetism
PALEOLATITUDES DETERMINED FROM PALEOMAGNETIC DATA FROM VERTICAL CORES
A. Cox (Dept. of Geophysics, Stanford University, Stanford, CA 94305), R.G. Gordon

Most of the paleomagnetic data available from oceanic plates consist of measurements of inclination but not declination from azimuthally unoriented vertical cores. Similarly, the basic paleomagnetic data to be analyzed from crustal blocks that have rotated by varying amounts about vertical axes are a set of paleoinclinations. A new method is proposed for determining the paleocolatitude of a sampling site and the associated confidence limits. Paleomagnetic inclinations are first converted to paleocolatitudes and averaged to produce a mean colatitude. After showing that this mean is biased, we derive a paleocolatitude correction to remove the bias, using a model for geomagnetic secular variation based on the latitude dependence of secular variation during the past 5 million years. After testing the validity of the model by applying it to paleomagnetic data from Quaternary lavas for which both inclination and declination are known, we apply the method to inclination-only paleomagnetic data from Suiko Seamount, the most complete data set from a drilling site. The method is then applied to paleomagnetic data from all DSDP sites for the Pacific plate to obtain for each site an unbiased mean paleocolatitude and its confidence limits. These paleocolatitudes and confidence limits are then used as input for a least squares analysis to obtain Early and Late Cretaceous poles for the Pacific plate and 95 percent confidence limits for these poles. It is shown that the scatter of individual site paleocolatitudes about the best fit pole is consistent with the confidence limits at each site as determined by the new method of analysis. (Paleomagnetism, plate tectonics, paleomagnetic poles, Pacific plate).
Rev. Geophys. Space Phys., Paper 3R1307

2590 Instruments and Techniques (Segregation vesicle rock orientation)
CRITICAL EVALUATION OF SEGREGATION VESICLES IN MID-OCEAN RIDGE BASALTS AS A ROCK ORIENTATION TOOL
N.A. Van Wagoner (Department of Geology, Dalhousie University, Halifax, Nova Scotia B3H 3J5)

Segregation vesicles in sea floor basalts generally are spherical in shape, 0.1 to 0.3 cm in diameter, and partly filled with a dark, cup-shaped meniscus of chilled residual melt. This residue presumably enters the vesicles sometime after crystallization is sufficient to maintain the shape of the vesicle but before final crystallization, and flows to the bottom of the vesicle before solidifying. The orientation of the meniscus can, therefore, be used as an indicator of the cooling orientation of the rock.
Results of statistical tests on 17 sea floor basalt samples previously oriented by megascopic geopetal features indicate that the menisci in segregation vesicles of a given rock sample are preferentially oriented about the earth's gravity field as indicated by the megascopic features. In all cases there is consistency of segregation vesicle and megascopic orientations. As well, the distributions of magnetic inclinations of rocks oriented by megascopic features and segregation vesicles are similar.
The segregation vesicle technique can be used to orient dredge and submersible samples for paleomagnetic polarity studies, and to determine the dip and pre-deformational magnetic inclination of rocks recovered in drill cores which have a known, in-place vertical orientation, if care is taken to properly select samples. Analyses of the scatter of segregation vesicle inclinations of 34 rock samples indicate that the error associated with dip and magnetic inclination determinations generally are less than ±3° and ±4°, respectively.
Of 158 submersible and dredge samples examined, 22% have segregation vesicles which can be used for rock orientation purposes, and 30% of the rocks examined from DSDP cores have such vesicles. Routine application of the technique to such samples has the potential of significantly increasing knowledge of the structure and paleomagnetism of oceanic crust. A simple method for application of this technique is presented. (Segregation vesicles, mid-ocean ridge basalt, magnetic polarity, structure).
J. Geophys. Res., Red, Paper 3B1161

Hydrology

3110 Erosion and Sedimentation
EROSION FROM LOW SLOPES
Calvin K. Mutchler (USDA Sedimentation Laboratory, Oxford, Mississippi, 38655), and K. C. McGregor

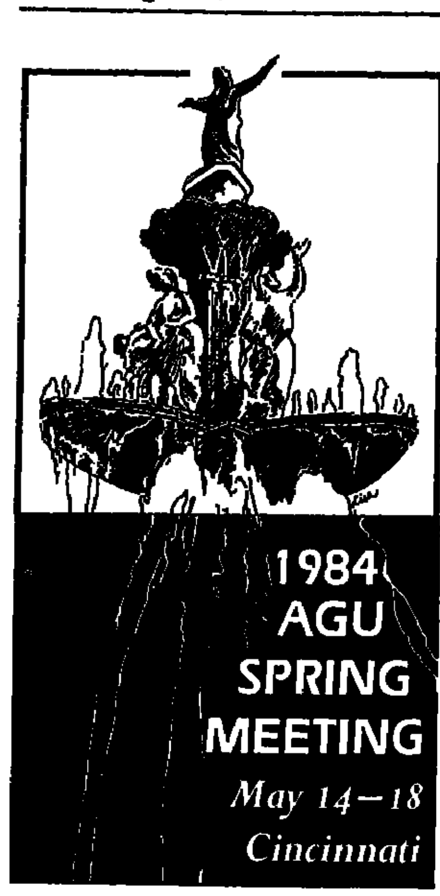
Simulated rainfall was used to generate erosion of plots, 22.9 meters long, on 0.1% slopes with different surface water depths. Maximum erosion rates occurred under an average surface runoff depth of about 2 mm. Erosion decreased with increasing depths greater than 2 mm; little change in erosion rates occurred for depths greater than about 20 mm. The results of this study suggest some interesting possibilities on the use of soil and water management to help control erosion of flatlands. Any tillage system such as bedding that leaves soil exposed to rainfall will result in high local erosion rates because only a very thin water layer will cover much of the soil surface. In contrast, any flow retardance that will increase surface water depths will greatly reduce erosion from the area covered. (Soil erosion, surface water depth, erosion of low slopes, mechanics of erosion).
Water Resour. Res., Paper 3W1223

3130 Groundwater (Aquifer Thermal Energy Storage)
AN ANALYSIS OF THE EFFECT OF SURFACE HEAT EXCHANGE ON THE THERMAL BEHAVIOR OF AN IDEALIZED AQUIFER THERMAL ENERGY STORAGE SYSTEM
O. Güven (Civil Engineering Department, Auburn University, Auburn, Alabama, 36849), J. G. Melville, and F. J. Molz

Analytical expressions are derived for the temperature distribution and the mean temperature of an idealized aquifer thermal energy storage (ATES) system, taking into account the heat exchange at the ground surface and the finite thickness of the overlying layer above the storage aquifer. The analytical expressions for the mean temperature may be used to obtain rough estimates of first-cycle recovery factors for preliminary evaluations of shallow confined or unconfined ATES systems. The results, which are presented in nondimensional plots, indicate that surface heat exchange may have a significant influence on the thermal behavior of shallow ATES systems. Thus, it is suggested that the effects of surface heat exchange should be considered carefully and included in the detailed analyses of such ATES systems. (Aquifer thermal energy storage, surface heat exchange)
Water Resour. Res., Paper 3W0492

3130 Groundwater
AN EFFICIENT FINITE ELEMENT TECHNIQUE FOR MODELING TRANSPORT IN FRACTURED POROUS MEDIA 2. NUCLIDE DECAY CHAIN TRANSPORT
Peter S. Huyakorn, Barry H. Lester, James W. Mercer (GeoTrans, Inc., P.O. Box 2550, Reston, VA 22090)

A finite element model is presented for simulation of nuclide decay chain transport in a naturally fractured porous medium system. The model is capable of representing the physical system using a dual-porosity approach, a discrete-fracture approach, or a combination of these two approaches. Advection and hydrodynamic dispersion in the fractures, as well as diffusion in the porous matrix and chain reactions of solute species can be taken into account simultaneously. An efficient finite element solution technique has been developed to solve a coupled system of governing partial differential equations. Via this technique, spatial discretizations and solutions of systems of algebraic equations for nodal concentration values in fracture and porous matrix domains can be performed separately. The present finite element model has been verified against analytical solutions. Two test problems involving transport of a chain of three components in unfractured and fractured porous media are presented to demonstrate the accuracy and efficiency of the proposed finite element technique. Results indicate that the present numerical model is capable of producing good predictions of breakthrough curves using relatively coarse spatial and temporal



3190 Techniques
SOME ALGORITHMS FOR PARAMETER ESTIMATION IN WATER RESOURCES SYSTEMS
[illegible]

3199 Miscellaneous (Real-time Flood Forecasting)
A STOCHASTIC-DYNAMIC MODEL FOR REAL-TIME FLOOD FORECASTING
[illegible]

3130 Groundwater
THE INTERACTION OF LAKES WITH VARIABLY-SATURATED POROUS MEDIA
[illegible]

3130 Groundwater
POSSIBLE EFFECTS OF EROSIONAL CHANGES OF THE TOPOGRAPHIC RELIEF ON PORE PRESSURES AT DEPTH
[illegible]

3160 Runoff and streamflow
INFLUENCE OF THE POINT BAR ON FLOW THROUGH CURVED CHANNELS
[illegible]

Meteorology

3710 Boundary layer structures and processes
MODELING THE DIURNAL DEPENDENCE OF THE OPTICAL REFRACTIVE INDEX STRUCTURE PARAMETER
[illegible]

3715 Chemical composition and chemical interactions
[illegible]

3715 Chemical composition and chemical interactions
THE COMPOSITION OF WESTERN ATLANTIC PRECIPITATION
[illegible]

3715 Chemical composition and chemical interaction
FORMALDEHYDE (HCHO) MEASUREMENTS IN THE NON URBAN ATMOSPHERE
[illegible]

3735 Electrical Phenomena
[illegible]

3740 General circulation
[illegible]

3799 General (Atmospheric measurements)
[illegible]

Mineralogy, Petrology, and Crystal Chemistry

4210 Crystal chemistry
[illegible]

4210 Crystal Chemistry
[illegible]

4220 Descriptive Mineralogy
[illegible]

4299 General (Seafloor Minerals)
[illegible]

Oceanography

4705 Boundary Layer and Exchange Processes
[illegible]

4713 Circulation
AN EXAMPLE OF METEOROLOGICAL EFFECTS ON THE ALBORAN SEA GYRE
[illegible]

4713 Circulation
[illegible]

4799 General Oceanography
[illegible]

4799 General (Hydrothermal Circulation)
[illegible]

Particles and Fields—Interplanetary Space

5310 Cosmic rays (electrons)
[illegible]

5310 Cosmic rays
[illegible]

5340 Shock waves (Shock-Spike Events)
[illegible]

5380 Solar wind plasma
[illegible]

5399 General (Wave Propagation)
[illegible]

Particles and Fields—Ionosphere

5505 Particles and Fields - Ionosphere (Airglow)
[illegible]

5505 Airglow
[illegible]

5505 Airglow
[illegible]

5520 Electric fields
[illegible]

5530 High-latitude ionospheric currents
[illegible]

5540 Ion densities and temperatures
[illegible]

5545 Ionospheric disturbances
[illegible]

5545 Ionospheric disturbances
[illegible]

5570 Total Electron Content
[illegible]

5590 Wave propagation
[illegible]

5590 Wave propagation
[illegible]

Particles and Fields—Magnetosphere

5725 Bow shock waves
A MECHANISM FOR PLASMA WAVES AT THE HARMONICS OF THE PLASMA FREQUENCY IN THE ELECTRON FORESHOCK BOUNDARY
[illegible]

5720 Interactions (Solar Wind)
[illegible]

5745 Magnetospheric Configurations
[illegible]

5736 Magnetic tail
[illegible]

5765 Plasma Instabilities
ON THE ORIGIN OF PLASMASPHERIC HISS: RAY PATH INTEGRATED AMPLIFICATION
S. R. Church (Poseidon Research, 1299 Ocean Avenue, Santa Monica, California, 90401) and R. M. Thorne

5763 Plasmapause
RARE GROUND-BASED OBSERVATIONS OF SIPLE VLF TRANSMITTER SIGNALS OUTSIDE THE PLASMAPAUSE

5780 Wave Propagation
THE SPATIAL STRUCTURE OF DIFFERENT ULF POLARIZATION TYPES — A REVIEW OF STARE RADAR RESULTS

Physical Properties of Rocks

6110 Elasticity, fracture, and flow
SUBCRITICAL CRACK GROWTH AND OTHER TIME AND ENVIRONMENT DEPENDENT BEHAVIOR IN CRUSTAL ROCKS

6110 Elasticity, fracture, and flow
RATE-DEPENDENT EXTENSIONAL DEFORMATION RESULTING FROM CRACK GROWTH IN ROCK

6110 Physical Properties of Rocks
SLIP INSTABILITY AND STATE VARIABLE FRICTION LAWS

6110 Elasticity, Fracture, and Flow
THE ROLE OF AQUEOUS FLUIDS IN THE INTERNAL FRICTION OF ROCK

6110 Physical Properties of Rocks (Elasticity, fracture, and flow)
FREQUENCY DEPENDENT ULTRASONIC PROPERTIES OF HIGH POROSITY SANDSTONES

Planetology

6510 Atmospheres of planets
NITROGEN ESCAPE FROM MARS

6510 Atmospheres of Planets
SOME OBSERVATIONAL CONSTRAINTS ON THE GLOBAL-SCALE WIND SYSTEMS OF MARS

6560 Meteorites
PHYSICAL PROPERTIES OF ORDINARY CHONDRITES

6575 Surface of Planets
STRENGTH OF MINERAL ABSORPTION FEATURES IN THE TRANSMITTED COMPONENT OF NEAR INFRARED REFLECTED LIGHT: FIRST RESULTS FROM RELAB.

6575 Surface of Planets (Mass Movement, Mars)
THE OLYMPUS MONS AUREOLE: FORMATION BY GRAVITATIONAL SPREADING

6599 General (Saturn Electrostatic Discharges)
STATISTICAL STUDY OF SATURN ELECTROSTATIC DISCHARGES

Seismology

6920 Explosion Seismology
TRAVEL-TIME ANALYSIS OF BOREHOLE SEISMIC DATA

6950 Seismic sources
ACTIVE FAULTING AND TECTONICS OF BURMA AND SURROUNDING REGIONS

6950 Seismic Sources
EARTHQUAKE FREQUENCY DISTRIBUTION AND THE MECHANICS OF FAULTING

6950 Seismic Sources
MOMENT TENSORS AND OTHER PHENOMENOLOGICAL DESCRIPTIONS OF OCEANIC INTRAPLATE EARTHQUAKES

6950 Seismic Sources
INDUCED SEISMICITY IN THE GEYSERS GEOTHERMAL AREA, CALIFORNIA

6970 Structure of the crust and upper mantle
AN ANOMALOUS LOW VELOCITY REGION ABOVE THE DEEP EARTHQUAKES IN THE JAPAN SUBDUCTION ZONE

6970 Structure of the crust and upper mantle
A SEISMIC REFRACTION SURVEY OF THE IMPERIAL VALLEY REGION, CALIFORNIA

Social Sciences

7110 Economics
OPTIMAL GROUNDWATER DEPLETION WITH INTERDEPENDENT NONRENEWABLE AND RENEWABLE RESOURCES

7110 Economics
THE ECONOMICS OF IRRIGATION WITH NON-UNIFORM INFILTRATION
E. Feinerman, J. Letey and H. J. Vaux, Jr. (Department of Soil and Environmental Sciences, University of California, Riverside, California, 92521)
Economic implications of non-uniform water infiltration in irrigated fields can be assessed with a simplified hydrologic balance model linked to an

7310 Economics
THE EFFECTS OF A CHANGE IN THE VARIABILITY OF IRRIGATION WATER

7310 Economics
CATEGORY-UNIT LOSS FUNCTIONS FOR FLOOD FORECAST-RESPONSE SYSTEM EVALUATION

... the flood damage sustained. The concept of category-unit functions is exploited to reduce field survey demands and to circumvent high computation requirements. The loss function consists of a unit damage function, a unit cost function, and a unit reduction function; the degree of response that can be actually implemented is bounded by a decision constraint function. These four functions are estimated from data of various origins for seven categories of structures and three categories of decision makers.
Water Resour. Res., Paper 3W1296

7310 Economics
MARKET SIMULATIONS FOR IRRIGATION WATER RIGHTS: A HYPOTHETICAL CASE STUDY

Nominations for 1984 AGU Fellows

Nominations for Fellowship in the Union are being sought by the Fellows Committee and the Section Selection committees. Nominees for Fellowship should be scientists who have attained acknowledged eminence in a branch of geophysics. The total number of Fellows elected each year cannot exceed 0.1% of the total membership.

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Name of Nominee ____________ Name of Sponsor ____________

Personal Data on Nominee

Business Address (including position held) ____________

Date and Place of Birth ____________

Education (degrees, institutions, major field) ____________

Professional Record (including special honors) ____________

Membership in Other Scientific Organizations ____________

Attach a list of most significant publications (not abstracts, book reviews, or papers that have not yet been accepted for publication).

Sponsor's Evaluation of Nominee

Attach a supporting statement which must include: (1) an indication of the length and nature of your acquaintance with the nominee; (2) the nominee's contributions to the field to date; (3) your evaluation of the nominee's scientific ability; (4) a one-line citation, "For . . . .", summarizing why the nominee should be elected a Fellow.

Signed ____________ Date ____________

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Solar Physics, Astrophysics, and Astronomy

7710 Corona
CONDUCTIVE DAMPING OF CORONAL MOTIONS

7710 Corona (Heliospheric Current Sheet)
COMPARISON OF HELIOSPHERIC CURRENT SHEET STRUCTURE OBTAINED FROM POTENTIAL MAGNETIC FIELD COMPUTATIONS AND FROM OBSERVED POLARIZATION CORONAL BRIGHTNESS

7720 Electromagnetic radiation
MEASUREMENTS OF THE SOLAR FLUX AT 320 nm

7750 Plages (Solar Irradiance)
SOLAR IRRADIANCE VARIATIONS. IV. ANALYSIS OF THE EXTREME ULTRAVIOLET MEASUREMENTS ON BOARD THE AE-E SATELLITE

Tectonophysics

8110 Convection currents
THE AMERICA-ANTARCTIC RIDGE

8150 Plate tectonics (spreading centers)
OVERLAPPING RIFT ZONES AT THE 5.5°S OFFSET OF THE EAST PACIFIC RISE

8150 Plate Tectonics
ON THE EVOLUTION OF MARGINAL BASINS

8170 Structure of the lithosphere
UNSTABLE EXTENSION OF LITHOSPHERE: A MECHANICAL MODEL FOR BASIN AND RANGE STRUCTURE

8170 Structure of the lithosphere (Electrical)
ELECTRICAL CONDUCTIVITY AND FLUIDS IN THE LOWER CRUST